# ISSUES IN DEVELOPMENT AND DIFFUSION OF INNOVATIONS IN MULTI ORGANISATIONAL SETTINGS

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# CERTIFICATE

It is certified that the work contained in the thesis entitled ''Issues in development and diffusion of innovations in multi organisational settings'' by S. Rajagopalan has been carried out under our supervision and that this work has not been submitted elsewhere.

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Indian tradition does not permit expressing gratitude to ones children and wife. I do not wish to brake away from the tradition. I dedicate this work to my children Harini and Aniruddha and to my wife Prabha.

( S. Rajagopalan )

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# CONTENTS

## LIST OF FIGURES



## LIST OF TABLES

## SYNOPSIS

Technology has played a major role in the economic development of nations. Technological development became one of the major concerns of the developing countries, which gained independence in the fifties. In India, despite explicit commitment to creation and adoption of innovations, the success stories are very few. In order to understand the causes for poor creation and poorer adoption, this study focuses on the process of innovation as it happens in the Indian environment.

The Indian environment has a few special characteristics. The government owns and controls a large fraction of productive enterprises, utilities and financial institutions. Almost all the funds for research and development is provided by the government. The government is also the major market for innovations. Different organisations are responsible for different stages of the innovation. the major phases, namely, development, adoption and diffusion of an innovation take place in different organisations and involve a number of decisions to pledge resources taken at these organisations. This study tries to understand how these decisions are made and who influences them. One of the important concerns of this study is the necessity of champions, to further the cause of innovation.

This study has adopted a case study method. 5 innovations in the areas of drinking water, housing and renewable energy were studied in depth. To maintain the features of organisation same, innovations where the development phase occurred in one academic

institute were chosen. The processes spanned nearly a decade for each of these innovations. All innovations were eventually adopted in government programmes.

The study followed the course of the innovations through various stages. It focused on the activities of those individuals, across organisations, who made significant contributions to the progress of the innovation. The study analyses the strategy followed by these individuals. It analysed the decisions taken in various organisations as an interplay between these strategies and the organisational processes in decision making.

Each of these innovations were attempted by more than one laboratory. The study also took a close look at the evaluation processes that were set in motion by adopting organisations to choose among various designs.

This research work concludes that champions are essential for successful innovations. It further points out that there must be a champion from the adopting organisation as well as a champion from the innovator group. These champions work together as an alliance and employ an entrepreneurial strategy. The champions influence the decision making in various organisations and if need be, would not mind converting the decision process into a political mode, by implicating other issues. The champions also influence the characteristics of innovation and change its focus, in order to make it successful. They increase the number of stake holders by roping in the manufacturers, provincial organisations, trainers, quality certifying agencies

etc. They institute a network to effectively carry on the diffusion.

This study also shows that evaluation committees try to arrive at a consensus and avoid dissent. This leads to fixing low standards, so that all aspiring innovations become eligible for government patronage. But which innovation actually gets adopted depends on the champions and their strategies.

These conclusions lead us to a larger framework of the innovation process in multi organisational settings. In each of the phases of the innovation, major activities are concentrated in one organisation. For example, the development phase takes place within an academic institute. The adoption phase happens in a federal government agency. At each of the locations there are forces promoting the innovation as well as forces against the innovation. These forces emanate both from the organisation and environment. The champions at every stage initiate a number of organisational processes to manipulate these forces to the advantage of the innovation. These processes include organising of resources, seeking approvals, removing the barriers and building commitment. The success or failure of an innovation, in Indian context, could then be explained based on the interplay of strategies, alliance of champions, and the forces from the environment and from the organisations.

# CHAPTER I

# INTRODUCTION

## 1.1. Innovation and Economic Development

Technology, in the sense of knowledge to produce useful goods and services, has played a major role in the economic development of nations. Material standards of living, the social life and securities of nations have been closely interwoven with the technologies they use. Hence, it is not surprising that technological development became one of the major concerns of the developing countries, which gained independence in the fifties. Rapid technological advancement became one of the cornerstones of the national development task.

In India, the recognition of the role of technology in development led to a commitment to the development and use of new socially relevant technologies.

The thrust of these initiatives have been creation and adoption of new scientific techniques which can make up for deficiency in natural resources and reduce the demand for capital. The scientific policy resolution adopted by the Indian Parliament expressed the commitment to create and adopt newer techniques (India, 1958). More recently, the government has emphasised that the efforts in technology development must be directed to achieve a greater spread in the use of technological

developments by optimally utilising the finite resources, in order to provide better quality of life to all sections of the society. (India, 1993).

Despite such explicit commitment to the creation and adoption of new technologies, the critical importance of ensuring adoption of the results of R&D was not given adequate attention. Over the last 45 years, a sum of more than Rs.136 billions have been spent on the research and development (India 1992(a)). Questions were being asked as to what tangible economic returns the nation had secured from this investment. In order to understand the causes for poor creation and poorer adoption of newer techniques, despite commitment from the government, we must look into the organisation for innovation, process of innovations and their adoption.

**1.2. Issues in Creation and Adoption of Innovations**

The commitment to the development and use of new scientific techniques led to the building up of the capacity for, what was termed as 'scientific and technical research. A number of research laboratories, each focusing on a special theme, were set up. These were set up on the premise that provision of adequate support to the scientists in these laboratories would automatically result in innovations and their adoption in the economy. It was assumed that there existed a market, actively seeking innovations, and hence adoption would pose little problems. Organising for creation of innovation, then became the focus of attention.

This assumption of the existence of an eager market for innovations was not entirely misplaced. The Indian government had adopted a mixed economy model of development, where a large portion of productive enterprises were owned and run by the government. Besides the government had taken up a number of programmes, providing goods and services at subsidised costs to identified sections of society. For example, there were programmes providing drinking water, subsidised housing and health facilities. There were also programmes offering incentives to citizens for adopting, socially beneficial practices. All these required, technological packages, that could spread the benefit to as wider a section of the society as possible. There was a need for innovations with a very large scale impact. The government itself became the market for innovations, and hence it was assumed that adoption of innovations by the government, under its programmes, would pose no problems. The innovations can then diffuse to other sectors of the economy.

Even if we restrict the scope of this study, to innovations required by the government sector alone, we find that there are at least three types of organisations involved in the process of creation and adoption of innovation. There are laboratories where much of the scientific and technical research is carried out. The knowledge emanating from such work have to be transferred to a manufacturing firm to produce the product in large numbers and distribute them. The entire process must be planned and funded by at least one government department. Thus, creation and adoption of innovations, in developing countries like India, happens in

multi-organisational settings.

In their eagerness to catch up with the already developed, the developing nations expect from their scientists, innovations which have a very large, economy wide impact. There is a preference to such 'mega' innovations, which provide visibility to the development efforts of the government. However, designs of existing organisations were not conducive to promote 'mega' innovations. The difficulties of (a) communication across interfaces, (b) orchestration of men and resources required to the performance of various tasks and (c) creation of a system for replication of the innovation on a larger scale were not considered. It seems that organising for innovation had been undertaken without much understanding of the process of innovations and their adoption.

### 1.3. The Innovation Process

There is no single, simple definition of innovation. It may be looked as a process by which knowledge on:

(a) how to produce a new product or

(b) how to produce an existing product more efficiently or more economically or

(c) how to reorganise the methods of production or distribution or usage so as to increase the effectiveness

is made a reality.

There are two crucial aspects of innovation (a) novelty and (b) economy. Innovations are controlled by two distinct sets of forces in an unpredictable way. On the one hand we have knowledge generation system comprising research groups, universities and laboratories, and on the other the market comprising the consumer, be an individual or a company or a government.

Novelty is essential to innovation. Sometimes, the novelty is so pervasive, the result is a totally new product. The Sony Walkman Cassette recorder or the 3M 'post-it' pads are examples of such totally de-novo innovations. Most of the times, however, the novelty is local providing a small incremental change resulting in higher efficiency. Then how do we distinguish an innovation from a mere change. The crucial determinant is the uncertainty involved in innovation. Though the process of innovation attempting improvements is mainly based on available, codified knowledge, there is some uncertainties regarding the outcome. For example, location of instruments on the dash board of an automobile may be changed which may result in reduction of labour time in assembly. Such technical changes are not innovation as there were little uncertainties. The change in dashboard was done through method study - a standard procedure of industrial engineering. However, redesigning the instrument panel for better visibility could be an innovation as the degree of uncertainty in this case is higher. Novelty, economy and uncertainty then determines whether a change is innovation or not (Sinha, A.P.; 1982).

Innovations have been looked at by most authors as an event, i.e. the occasion of occurrence of innovation, or an outcome, or a process. The innovations are, as outcomes viewed as either a new product or a new production process or a new way of organising the production and distribution.

It may be worthwhile to look at innovations with a larger scope. Innovations may be considered not merely novel changes brought in product or process or organisation, but also the methods or strategies by which these changes were brought into effect. This larger view of innovation as process, would encompass organisational processes that have a bearing on the innovation. In multi organisational settings, then a study of innovation process would mean the study of the innovation process from the recognition of opportunity to adoption and also the study of various strategic processes in multiple organisations that helped or hindered the progress of innovation.

**1.4. The Stages of Innovation**

Most authors studying the innovation process have come to the conclusion that it is possible to identify distinct stages in the process. Each stage is distinguished from another by the difference in the nature of the activities undertaken during that period.

The stages normally include (a) identification of an issue or an opportunity, (b) search from the existing knowledge, (c) appraisal of existing techniques, (d) design of a new

invention, (e) seeking commitment from market, (f) trial/ demonstration, (g) incorporation into regular practices of users and (h) diffusion.

Identification of an issue or opportunity would include activities that express needs, raise criticism, indicate aspirations, and priorities problem areas etc. Under 'search' innovators seek information on relevant technologies, become aware of existing methods, their costs and obtain information on local condition to evaluate whether an existing innovation could be the solution. Appraisal is a stage wherein potential solutions, borrowed from existing knowledge is evaluated, to see whether they suit local needs or not. If no suitable solution is found, then the activities of design of a new solution is undertaken. The 'design' would not only involve development of an innovation, but also the activities related to evaluation of the design. The function of seeking commitment is concerned with activities of identifying and mobilising support for the innovation. 'Trial or demonstration' relate to those activities under which the innovation is applied, evaluated by potential user/purchaser and is modified.

We must note that there are 3 distinct sets of activities dealing with evaluation or appraisal. The scientist first evaluates solutions existing elsewhere to see whether any one of them can be used. If not, he designs an invention. This is evaluated by him to check whether it meets all the design criteria. Then there is an evaluation by potential users. The

decision maker here would impose broader criteria to judge the innovation. We would term the earlier evaluation done by the scientist as 'design appraisal' and the evaluation done by a user or an adopter as 'adoption appraisal'.

The innovation proceeds from one stage to another stage only when supporting decisions to pledge resources are taken at every stage. The decisions involved are:

1. preliminary design funding decision
2. development funding decision
3. decision to manufacture by a manufacturer
4. decision to adopt the innovation by the user

As can be seen, different organisations and individuals are involved in making these decisions. What induces them to make the crucial decisions at every stage to push the innovation along? The focus of this study will be on this crucial issue. More specifically how are innovations developed and adopted in government programmes?

**1.5. Scope of This Study**

This study concerns itself with the innovations whose creation and adoption were sponsored by the government in India, a developing country. One would expect an easier and smoother progress for the innovation through the various stages, as the entire process is sponsored by the government. But the arm of the government sponsoring creation is different from the arm of the government for whom the innovation is intended. The transfer of

results of R&D from one arm of the government to another arm have always been problematic.

In this study we focus on 5 innovations in the areas of drinking water, housing and renewable energy which were successfully pushed along the entire course of innovation and were adopted in the government programmes. It is hoped that some common patterns would emerge indicating the causes for their success.

This study lays a greater emphasis on the process of adoption into a government programme and examines the roles played by innovators, sponsors of research and development, champions if any, and adopting organisations. Using the method of in-depth case studies, this study tries to arrive at the strategy adopted by different groups during the course of innovation.

This study essentially follows the course of the innovation through various stages. The study focuses on the activities of those individuals who made significant contribution to the innovation's progress at critical stages. If there were more than one such 'champion', the study tries to investigate whether there was an understanding or alliance among different champions.

What kind of strategies did these champions evolve and implement during various stages? The study tries to understand the sequence of events as an outcome of a strategy put in force by the champions. It also looks at the effect of these strategies on the decision processes of adopting organisations.

During the interaction between the innovators, their champions and adopting organisations there would have been suggestions regarding the innovation, its characteristics, and its focus. How did the innovation get affected due to these interactions? The study tries to analyse the causes for changes in the innovation characteristics, if any.

The dissemination of an innovation requires coordinated action by a number of organisations such as manufacturers, retailers, educators, and users. In a commercial innovation, the market and price relations ensure such coordination. But in the case of an innovation spreading through government programmes, such a network need to be established. The creation and structuring of such a network and the inter organisational relationship is another area of concern for this study.

It is quite natural that the same innovation is attempted in more than one laboratory. In countries like India, all such attempts are funded by the government, may be through different channels. How does the adopting organisation react to multi locational developments resulting in different design solutions for the same problem? What are the kinds of interaction between these research groups? These questions are also looked into in this study.

The major objective of this study is to identify factors responsible for successful development and adoption of innovations in government programmes. It is hoped that an

understanding of this process will provide the illumination required to embark upon a better management of the innovation process in government programmes.

# CHAPTER II

# A REVIEW OF THE LITERATURE AND PRELIMINARY HYPOTHESES

Innovations have been studied in literature along three broad streams - namely, stages of innovations, adoption of innovations and the factors affecting the innovation process. These studies include the role of innovation champion and look at innovation as strategic process setting motion by the champions. We discuss these and other related aspects from literature in this chapter. A set of preliminary hypotheses are derived towards the end.

## 2.1. Innovation Process

### 2.1.1. Innovating stages

Various authors have studied the process of innovation mainly from two angles. There are researchers, though a few, who have attempted to study the information flow during the process of innovation and others who have studied the nature of activities undertaken during the course of innovation. However all of them agree that it is possible to identify distinct stages in the process. Each stage is distinguished from another by the difference in the nature of activity. For example Myers and Marquis identify recognition, idea formulation, problem solving, solution, utilisation and diffusion as distinct stages. (Myers, 1974). Pelz analysed 18 urban innovations requiring active government support in the area of energy conservation, recovery of energy from solid wastes and community noise control (Pelz,

1983), and he concluded that

1. Stages do exist
2. They occur separately in time
3. There is a particular sequencing of stages.

He identified 8 major 'functions'. They are: concern, search, appraisal, design, commitment, implementation, incorporation and diffusion. What distinguishes this study from others is the further division of dissemination into functions of seeking commitment, trial implementation in a locality/subarea, incorporation as a regular practice and diffusion.

Pelz found that there was a substantial overlap among many of the functions especially search, design and appraisal. Search started before design and appraisal but all the three ended at the same time. Pelz also found that the functions appeared in clear order: concern, search, design, appraisal, commitment, implementation and diffusion. Pelz also noted that though the function of commitment building, an important one for innovation spreading under government sponsorship, overlapped with 'search', but a majority of the activity of commitment building occurred after the innovation was designed and appraised.

Pelz had postulated two distinct functions, viz., implementation and incorporation, in the innovation process. Implementation included those activities when the innovation is applied or evaluated or modified, <u>prior</u> to large scale dissemination. Incorporation meant acceptance of innovation as a standard procedure with a claim on resources. However in the

study he could not distinguish between these two functions and merged them to a single function called implementation.

If we look at these functions, in a multiorganisational setting, the functions of concern, search, design and appraisal take place in a research organisation. The function of commitment seeking takes place in an adopting organisation. Many uncertainties in design had to be resolved before their advocates could begin to sell them. Pelz states that persuasion often depended on compromises in design. Hence commitment building activity took place once some clear idea about innovation emerged.

Utterback offers a scheme by which he groups these various activities into three phases. (Utterback, 1974).

(a) Generation of an idea involving synthesis of diverse (usually existing) information, including information about a market or other need and possible technology to meet that need.

(b) Problem solving including setting specific technical goals and designing alternative solutions to meet them, and

(c) Implementation consisting of manufacturing, market starting required to bring the invention to the first use or market introduction; Diffusion takes place in the environment and begins after the innovation is first introduced.

In our study, we group the innovation functions into three phases. Utterback does not have a separate category for commitment seeking activities. But in innovations in multiorganisational settings, this is an important activity. We combine the activities of generation of idea and problem solution to one phase. We propose that the innovations could be analysed using the following three phases:

(a) Development phase: This phase includes the functions of concern, search, design and appraisal and usually takes place in a research organisation.

(b) Adoption phase, includes the function of commitment seeking and takes place in our study, in a federal level adopting organization.

(c) Implementation phase: This phase includes the functions of implementation and diffusion and takes place in a network of organisation.

### 2.1.2. Information flow during innovation

What makes the innovation proceed from phase to phase? The literature does not provide a very clear answer to this question. From a look at the literature on innovation stages, we can surmise that innovation is inextricably concerned with interfaces between various groups responsible for carrying out activities required for successful completion of various stages. It is on the identification of such interfaces and on ensuring smooth flow of information and action across each of them that successful innovation largely depends (Parthasarathy, 1987). Other authors

such as Myers and Marquis have also emphasised the importance of flow of information across interfaces.

The innovation proceeds along only when supporting decisions to pledge resources are taken at every stage. Hence information flow to the decision makers becomes important.

Though information flow has been identified as one of the critical elements in the innovation, it is not clear what or who makes the information flow across interfaces.

## 2.2. Innovation Adoption

### 2.2.1. Innovation adoption and innovation characteristics

A number of studies have looked into the process of innovation adoption by an organisation. They have tried to correlate characteristics of innovation and their eventual adoption and implementation. Some have attempted to analyse innovation characteristics, organisational characteristics and their interplay in the adoption process of an innovation.

A meta-analysis of 75 research studies on innovation characteristics and innovation adoption-implementation, by Tornatzky and Klein (Tornatzky, 1982) has shown that 30 characteristics have been used in these studies. However a close perusal of these indicate that there is considerable overlap among them. For example, capital cost, continuing cost, initial cost, pay off, profitability, rate of cost recovery etc., have been used by different researchers to indicate economic viability

of the innovation. Tornatzky and Klein feel that compatibility, relative advantage and complexity could be the major characteristics of the innovation, that could explain adoption behaviour.

In a study of stages of innovation, Pelz has used the characteristics originality and complexity to explain the nature, duration and sequences of stages. (Pelz, 1983; op.cit). The following operational definitions of these characteristics are from the above studies.

**Originality**: Any innovation has two parts, the hardware (equipment) and the software (methods of use, maintenance). High originality means that both these parts are being thought out for the first time. Medium originality would mean adaptation, i.e. a few others have used the technology with or without success, that innovation is modified in either or both parts to suit local conditions or to remove the causes of earlier failure. Low originality would mean virtually replication of prior experience of others.

**Complexity**: The complexity of an innovation is the degree to which the user requires in-depth training to enable him to understand and use. Complexity can be deduced from the following aspects of the innovation - communicability, ease of operation, user pre-requisites of education/skill, and relations between parts of the innovation (rigid, flexible, loose etc.)

**Relative advantage**: This is the advantage as perceived by the user who is likely to adopt the technology over the existing

way of fulfilling the same need. This factor will not exist for an innovation which is so novel that it creates a totally new need. The relative advantage will be measured by the following aspects:

(a) Economic: Capital and operating costs, payback periods, risks involved
(b) Time: saving of time to complete the tasks
(c) Drudgery reduction (amount of human energy required and repetitiveness of the operation and variety in the job design)
(d) Occupational hazards

**Compatibility:** The compatibility is the degree to which the innovation matches with (a) values, attitudes etc., of the user and (b) with the existing practices - i.e. requiring little change of behaviour and practice.

Studying the sequencing of innovation functions, Pelz found that innovations with medium originality were more ordered, i.e. the sequencing of functions were clear and there were very little overlapping of functions. High degree of originality and a high degree of complexity makes the process very muddled.

In their analysis, Klein and Tornatzky found that compatibility and relative advantages were positively rated to adoption while complexity was negatively related. They feel that these characteristics need further conceptualisation. Researchers too often failed to specify the criteria for judging these

characteristics. These studies have shown that innovation characteristics alone are not able to explain, much less predict the innovation adoption behaviour due to (a) problems with measurement of the characteristics, (b) problems with measurement of implementation-adoption and (c) lack of understanding of the process. Klein and Tornatzky conclude that there is a need to study other independent variables in addition to innovation characteristics. They may be measures of organisations.

**2.2.2. Innovation adoption and organisational characteristics**

A landmark study of success and failure in industrial innovation (SAPPHO) conducted at the University of Sussex (Robertson A.B, 1972), covered 29 pairs of innovations in chemicals and instrument industries. Each pair consisted of one success and one failure. This study basically concentrated on organisations innovating within and adopting their own innovations. The study concluded that organisations with significantly better understanding of user needs, which paid more attention to marketing tasks and which made more effective use of external technical resources were successful. These organisations had also assigned the responsibility of innovation to a more senior executive.

A number of researchers have also looked into the relationship between organisational structures and their ability to adopt innovation. The main theme of these studies is that firms with certain organisation structure may have more difficulty than others with the adoption of technical change. After a study of 110 English manufacturing firms, Woodward

concluded that one particular form of organisation was most appropriate to each system of production. Technical change that altered the basic method of production led to organisational change (Woodward, 1965). Richard Normann, studying product innovations in Sweden suggest that a product ties the firm to a specific portion of the environment, namely the domain which is that part of the environment with which the organisation is in more or less constant interaction. The characteristics of successful products must be **consonant** with the needs and values of the domain. Product innovations often will lead the firm into new domains with generally profound consequences for the value and power structures of the organisation (Normann, 1971).

Then for successful development and adoption of an innovation, (a) the innovation must possess all the right characteristics, (b) the information flow across stages to various groups are maintained, (c) the adopting organisations have the right structure that would enable them to change the value and power relationship as required by the introduction of the new innovation, and (d) the organisation be sensitive to the needs of the market and changes in the environment.

Do these conclusions apply to the cases of developing countries where both the development and adoption of large scale innovations are carried out under government sponsorship? Are these sufficient conditions for success?

In countries like India different organisations have been

responsible for different stages of innovation. Normally the stages of search, appraisal and design are carried out in a laboratory or in an academic institution like the universities. Manufacturing is the responsibility of companies both in the public and private sector. In most cases the initial market start up, field trials and implementation are the responsibility of the government departments and their agencies.

Then, for an innovation to succeed, someone must play the boundary spanning roles, namely, a role of information carrier across organisations, a role of influencing the decision making in these organisations so that adequate resources are mobilised at every stage of innovation. Who are these special people?

### 2.3. Innovation Champions

The role of individuals seems to be quite important. In their work, the SAPPHO team, collected information about key individuals. Three distinct functions were performed by key individuals:

(a) <u>Technical innovator</u>: The 'inventor' or the single individuals who made the major technical contribution to the development/design of the innovation. He is likely to be a member of the innovating organisation.

(b) <u>Innovation Manager</u>: The individual who was actually responsible within the management structure for the overall progress of the innovation project.

(c) <u>Product champion</u>: Any individual who made a decisive contribution to the innovation by actively and

enthusiastically promoting its progress through critical stages, whether he had management responsibility for all or part of the project or not.

In some cases one individual played more than one role. There were cases for instance where technical innovators or innovation managers playing the role of product champions. (Robertson, 1972 op.cit).

Jane M Howell and Christopher A Higgins have added on some more roles for champions. (Howell, 1990). Champions act as:

(a) gate keepers: acquire, translate and disseminate external technical knowledge

(b) user champion: implement, train and assist users.

How do we identify champions? Howell mentions that champions provide inspirational leadership, have qualities of risk taking, persuasion, persistence and initiate more frequent and more varied influence attempts.

The studies by the University of Sussex (SAPPHO) and others have indicated existence of more than one individual performing the key function of championing the innovation. Different champions may emerge at different stages of the innovation and help in further progress of the innovation. Do these champions act independently or is there a coordination among them? Since the innovation they are championing is the same, we can expect some amount of coordination among them. But this question has not been addressed by any study so far.

What are the strategies adopted by these champions? James Brian Quinn believes that existence of champions alone won't do. Technological change progresses in a probabilistic, tumultuous and interactive fashion, driven by few champions. Careful links between strategic planning with novel organisational and motivational approach are used by successful companies. (Quinn J.B., 1985).

It emerges that looking at innovations and their progress as determined by the strategies adopted by champions may be an useful approach.

## 2.4. The Strategy of Champions

### 2.4.1. The Contexts of Innovation

Studies of innovation processes and causes for their success or failure have so far focused on characteristics of innovation or features of the organisation or existence of champions. Though they have been able to determine to some extent factors associated with success of innovations, they are unable to explain the differences between innovations and much less to predict the outcome of an ongoing innovation.

Innovation process is influenced by the environing social and cultural structure. The collection of forces outside the process of innovation that influences its outcome is the context of innovation. The organisational context of innovation will include among other organisation's goals, formal structure, leadership and resources. Environmental context includes

technological trends, government policies, competitor behaviour and demand trends.

In a developing country like India certain features of organisational and environmental contexts have a bearing on the innovation process. Some of them identified by Parthasarathy are listed below:

(a) Different institutions are responsible for different functions in the innovation process. For example, the functions under the development phase are normally carried out in a research laboratory or in an academic institution. The activities connected with adoption, takes place in a government organisation and network of producers, implementors and others takes the phase of implementation. This led to managerial separation of functions.

(b) Information flow across organisation is very poor. This leads to interface problem.

(c) There is not much ability to forecast accurately the demand for an innovation. This leads to a mismatch between innovation demanded and innovations attempted and available.

(d) The capacity to convert a concept into a product, i.e. the production engineering capacity, to meager. The manpower required for this task is neither available in research laboratory nor in manufacturing firm.

(e) Most of the innovations are still imported. This has prevented the laboratories, manufacturers and others

from having to face the difficulty of true innovation.

In the organisational context, most of the research laboratories are organised on the lines of academic institution with specialised departments and each scientist is as autonomous as a faculty of the university. Secondly, the reward structure values more the publications of research in international journals and standing in the international community. This colours the set of problems chosen by the scientists to work on. Thirdly, a number of scientist groups in different organisations work on the same innovation with very little cross flow of information and discussion. This leads to conflicts.

There are some positive factors too! Mainly among them is the availability of finances from a number of government agencies and eagerness of organisations to support socially relevant large innovations. The operational freedom available to the scientist is also large and there are no institutional barriers to overcome. The scientist could, if he chooses, act as a champion.

**2.4.2. Strategies of champions**

It is believed that managers or champions could influence the organisational context to a large extent and even the environmental context to some extent, by adopting suitable strategy. Factors such as organisational goals, structure and leadership have been identified as some of the important factors affecting innovation, as we had seen earlier. The concept of strategy may explain how they affect.

It is the belief of some researchers like Utterback and Rosenbloom that the introduction of a powerful and overlooked variable 'strategy' will shed important new light on subject. (Rosenbloom, R.S.; 74).

Very few studies of such nature are available. In an analysis of technology policy in a Japanese firm, Toyota Motor Company, Bruce Rubinger indicated that a strategy of joint activity on Research and Development with the suppliers gave the company an edge in meeting the competition. (Rubinger, B. 1985). Another study of European strategic programme for research and development in information technologies ESPRIT, by Pedro, highlighted the existence of linkages between companies, research institutes and governments at the regional, national and the international levels. These linkages were the outcome of strategic planning (Pedro N, 1985).

**2.4.3 Internal Corporate Ventures and Innovations:**

A number of studies in the last ten years have looked in to the process of internal corporate venturing. These studies have shown the activities of venture champions as an important element in the determination of the success of the venture. A significant study by Burgelman ( Burgelman, 1988 ) highlights the process of strategy making by champions in ICVs. In a study of three ICVs Burgelman contends that the strategy of champions is evolved in a social learning process. He identifies three distinct phases in the process. Initially the operational manager champions the cause of a new venture. He initiates strategic forcing activities

by putting together a few prototypes and pushing them in to the use environment to attain toe hold. His actions and lessons from his experience is used to build an arena strategy at the middle level. the initial champion from the operation level and the new champion from the middle level now use their learning to develop a limited field strategy for a new business venture. The arena strategy helps on one hand to correct the mistakes, effect changes in the venture and on the other communicates with the corporate management demonstrating the potential of the venture. The network of champions then engage in institutionalisng the new venture in the strategic plan of the corporation.

**2.5. Alliance of Champions**

Though formation of coalitions within organizations to achieve a common objective have been studied, such behaviour among individuals from <u>different</u> organisations have not been discussed. However it will be useful to look at the progress of multi-organisational innovation process as an outcome of a strategy evolved and implemented together by champions. We specify that an alliance of champions exist if (a) there are frequent communication among them, (b) they work to a large extent together in the cause of innovation and (c) the course the innovation takes is acceptable to all of them. There would then be an indication that they evolved a strategy together and implemented their respective role as specified by the strategy. They bring to the alliance their expertise, power and to some extent their organisational resources.

It would be interesting to study how the alliance is brought into existence and how it functions. Elements of the strategy evolved by the alliance would include (a) legitimising the activity of the alliance in their respective organisations, (b) affecting the crucial decision processes, (c) lowering barriers to the innovation, and (d) establishing the inter organisational relationships and network required to produce, finance, and market the innovation and train the user.

**2.6. Modes of Strategy Making**

How are these strategies made? Henry Mintzberg identifies strategy making in three modes (Mintzberg, 1980). The modes are the entrepreneurial mode, adaptive mode and planning mode. In the entrepreneurial mode the strategy ensures active search for new opportunities, is generally proactive, and there are dramatic leaps forward on the face uncertainty. The power is centralised in the hands of chief executive who takes high risks.

Strategy in the adaptive mode follows the path of disjointed incrementalism, is generally reactive to events occurring in the context, does not have clear overall goals but only looks for incremental small progress.

Strategies in the planning mode anticipates the decisions, it has a system of choice to choose from alternatives, employs detailed analysis of costs and benefits of each move and is integrative.

James Brian Quinn has postulated that effective strategy

stems from a series of strategic sub-systems. There is a powerful logic in formation of strategy at subsystem level, similar to the Mintzberg's strategy in planning mode. Since there are cognitive and process limits in any organisational setting, these sub-systems are linked using an incremental adaptive process. For example strategy evolved by the manufacturing unit or a marketing unit of an organisation may be logical in themselves. But the corporate strategy is an adaptive blend of these sub-strategies. Such adaptive processes are responses to precipitating events in the environment. Since the organisations can not understand the full implication of the alternatives, they can not use a logical process of strategy making (Quinn, 1980).

Then do champions follow the strategy of logical incrementalism as there are precipitating events in the environment of innovation or do they evolve an entrepreneurial strategy with dramatic leaps on the face of uncertainty?

There have been, as we have stated earlier, no studies that would answer these questions. We have seen that in the context of developing countries, the organisations responsible for different stages of innovation are different with very little interaction among them. The strategy of champions must be able to influence the decision process in these organisations.

## 2.7. Decision Processes

### 2.7.1. Models of Design Process

Decision processes in commercial organisations,

universities, and government have been subject of much study and theorisation. There are three main theories - the incrementalism theory, the dual rationality theory and the garbage can theory. Most of the hypotheses and findings could be fitted into one of these main theories. Typically the decision process encompasses, according to Mintzberg, all those steps taken from the time a stimulus for an action is perceived until the time the commitment to action is made. The decision processes essentially viewed as a problem solving process. (Mintzberg H, 1976).

Main formulation of the incrementalism theory came from the "Carnegie School". Propounded by Simon, March and others this theory believes that managers and organisations are intendly rational within the limits of differing managerial attachments to problem priority, limited capacity to solve and a limited knowledge of the future. Hence they tend to bargain, form coalitions and undertake a limited search. They develop a limited set of criteria and if a solution satisfies these bare essentials, that solution is adopted. Sequential attention to goals, uncertainty avoidance, and simple minded search (whereby decision makers prefer alternatives that are not far away from what is being done already) are the hallmark of this kind of decision process (Hickson D.J., 1987).

Lindblom in his seminal essay "The Science of Muddling through" illuminates this theory with studies on public policy making. He points out that since the decision makers in the government do not have a consensus on the goals, they prefer only

small changes. This theory states that problem-solving methodology is rational, albeit limited by the narrow incremental view. (Lindblom C, 1959).

On the contrary, Mintzberg, the main spokesman for the dual rationality theory, contends that the decision-making is a process of handling both problems and politics. A study of 25 decision ranging from raising of retirement age to buying of an airplane, gave raise to the now famous 'structure of unstructured decision making'. The Mintzberg model, identifies 3 phases in the process of decision making. They are identification phase, development phase and selection phase. These three phases have 7 stages. Mintzberg has identified interrupts as well as cycling among stages. The process is iterative. Mintzberg and his co-workers have identified seven kind of processes; simple impasse, political design, basic search, modified search, basic design, blocked design and dynamic design processes. Of the 25 decisions investigated 15 were broken by interrupts and all of them showed cycling.

Hickson and his co-workers studied 150 decision processes in 30 organisations. This study known as Bradford studies, supports the contention of Mintzberg that decision making is both problem solving and interest accommodating. They identified discontinuity (akin to "interrupt") as well as dispersion (more and more persons are involved). Based on these, they categorised the processes into three kinds: sporadic processes - informally spasmodic and protracted; fluid processes - steadily paced, formally channeled and speedy; constricted process - narrowly

channeled (Hickson D.J, 1987 op.cit).

In contrast with these two theories, the theory of garbage can insist that decision making process in organisational anarchies (i.e. organisations with problematic goals, ambiguous methods and fluid participation) is moulded by occurrence of independent streams, in continuing time of:

1. problems (concern of people inside and outside organisation)
2. solutions (usually someone's product, an answer actively looking for a question), and
3. participants whose attention to a problem or attachment to a solution depends on competing demand for time.

All these streams come together in choice opportunities (i.e. when an organisation is expected to produce a behaviour, which can be called a decision). This approach negates any role for rationality in decision making.

The question naturally arises is whether the occurrence of a particular model of decision making among the three depends on the (a) nature of organisation, (b) nature of problem and (c) nature of leaders, champions etc. Mohr proposed that variable characteristics of organisations (e.g. ownership and functions) and of problems raised and the interests implicated by the matters on hand can be used to explain the probabilities that one type of decision making process will occur rather than another. For example, the garbage can model seems to fit well, in fact emerged from an analysis of, decisions made in colleges and

universities. (Mohr, L.B, 1982).

### 2.7.2. Decision process in government

In this study we are looking at organisations generally controlled by the government. Various authors have studied decision process in large organisations including government departments. Graham T Allison has categorised these processes in three modes:

(a) Rational policy model where action is a rational choice based on a clear understanding of cause-effect relationships and a knowledge of options to meet pre-determined specific goals.

(b) Organisational process model where actions are output of organisational functions guided by standard behaviour. The actors have fractioned power, parochial priorities, have set programmes and repertories. Uncertainty avoidance through negotiated environment is given preference. Different sub units process different issues, hence goals are set by constraints defining acceptable performance. They use standard operating procedures.

(c) Bureaucratic political model where action is outcome of bargain; players are in hierarchical position with parochial interests, stakes and fractioned power. Action is an outcome of politics as highlighted by uncertain environment. The outcome is determined by the time

pressure or pace on the system and the selection of actors. The people, the time and the structure of power all determine the outcome. The attention of the organisation is on a series of problems and there is no particular focus on any one issue at a time. There are streams of outcomes. (Allison, 1980).

If we adopt Allison's conceptual models, departments of governments are likely to adopt either the organisational process model or bureaucratic politics model while adopting innovations. When the pressure to act is high and uncertainty is large they are likely to adopt the political model. In ordinary times, they are bound to use their programmes and repertories and attempt uncertainty avoidance through negotiations in order to maintain acceptable level of performance. In other words, they use the organisational process model.

Then how do champions and their strategies affect this process. The champions may either be within or from outside the organisation. Champions by their acts can increase the pressure and increase the pace of the process. They can enter into negotiation in order to ensure that the organisation maintains its level of performance. They could also increase the pressures from the environment in such a way that the organisations adopt the bureaucratic politics model in which case the champions would be players in the game.

## 2.8. Interorganisational Relationships

We have seen that relationships between organisations become necessary in order to develop and disseminate innovation. Champions help in forming such links by playing a boundary spanning role.

Why do organisations establish relationships? Organisations pursue a supply of scarce resources; money and authority. Interaction and sentiments are dependent upon their power to affect flow of these resources. The relationships grow due to the commitment by the parties to formalise the relation and build a consensus. This consensus is an outcome of the resource dependency and also on the communication. The relationship is initiated by a single organisation which sets in motion mobilisation coordination to gain support, cooperation and resources from others. (Van de van, 1984).

Van de van also points out that such inter organisational relationships are established for specialised requirements to fulfill an unique objective. The relationship is influenced by domain similarity (i.e. common services, clients or skills), resource dependency and communication. Levinthal argues that in addition to resource dependency and uncertainty avoidance, these relationships are influenced by the history of prior relationships. Personal relationships among individuals in both organisations in boundary spanning role provides the basis for endurance. The transactions are based on either economic exchange or social exchange (Levinthal D.A, 1988).

The relationships are brought into existence by (a) legal

mandate or (b) formal agreement or (c) voluntary cooperation. The basis for interaction can be (a) an exchange of resources, (b) legal requirement, or (c) voluntary cooperation to gain social status. (Hall R. H., 1977). The relationship is controlled by control of interaction methods, information flow and a procedure for conflict resolution (Zeitz G, 1980). According to Williamson, individuals play a crucial role in coalition formation by providing information and leadership and by affecting decision process (Williamson, 1978).

However it has been noticed that formal aspects and controlled communications do not work to the advantage in some multiorganisational system. The provision of formal, authoritative channel of communication may suppress rather than encourage sharing of information. Informal agreements can be worked out bilaterally between particular participants; formal agreements often require multilateral agreements, increasing complexity. Norms of reciprocity governs the relationships among loosely coupled organisations - not market transactions (Chisholm, 1989).

Then to form a network of organisations there must be either resource dependences or requirement of specialised tasks. These relationships are established by law or by formal agreements or by voluntary cooperation. The relationships are maintained because there is an economic advantage or a social exchange or due to legal requirements.

## 2.9. The Learning Process and Change in the Innovation

We have seen that the innovation goes through a number of functions and different champions play key roles. In the interaction between the innovation and the environment, mediated by champions, there may be situations wherein either the characteristics of the innovation or its focus may get changed. How do innovators and their champions respond to such stimuli for change?

This behaviour could be modeled as a learning process. In a learning process, stimuli from environment are analysed and based on a set of norms or criteria, a behaviour emerges. In their seminal work on organisational learning Argyris and Schon described two modes of learning - single loop learning and double loop learning. When the error detected and corrected permits the organisation to carry on its present policies, then the process is single loop learning. Double loop learning occurs when the response involves modifications of underlying norms, objectives and policies. Organisations set up systems that inhibit double loop learning. People in general tend to unable to reflect and question their own governing values (Argyris, 1978). Extending this framework to changes in innovation, we may postulate that innovators in general refuse to accept changes in core characters of their innovation. However champions and their strategies may try to influence their learning behaviour, which may alter the scope of innovation.

## 2.10. Summary of the Review of Literature

In conclusion the review of literature suggests that

(a) innovation proceeds in stages (in a broad sequence)

(b) characteristics of innovation, features of organisations and features of environment influence innovation adoption

(c) champions promote progress of innovation by maintaining communication across organisations and influencing their decisions

(d) strategy may be an important element in determining innovation's progress.

But there is no clarity on

(a) whether there are alliances of champions

(b) what kind of strategy is adopted by champions

(c) how do they influence organisation decision making

(d) how the network of organisations to disseminate innovation is set up, maintained and controlled, and

(e) how the interaction between innovation and environment progress.

## 2.11. Preliminary Hypotheses

### 2.11.1. The scenario

Most of the innovation process research, published and reviewed in the literature have concentrated on situations wherein the entire process from concern to implementation take place within one organisation. Some studies have focused on the issues of transfer of an innovation from laboratories to manufacturing companies. A number of studies have analysed the

process of adoption of an existing, but recent innovation, by firms. Very rarely, any study has attempted to understand a process that spans a number of organisations.

The issues which we have taken up for exploration in this study concern itself with the process of innovation in multi organisational settings. Different phases of the same innovation happens in different organisations. Secondly, our study is concerned with those innovations which have nationwide impact and in that sense they are mega innovations. Thirdly, the resources for carrying out the innovation comes from the government and the diffusion of the innovation is also orchestrated by the government. They are not 'de novo' innovations, but are significant improvements over the existing devices. In such situations extrapolating research results obtained from different situations is likely to be problematic. Nevertheless, it may be worthwhile to propose, a few hypotheses.

### 2.11.2. Innovating stages

In our study, the innovation not only proceeds from one function to another, but also moves from one organisation to another. It is likely that it would be possible to identify the various innovation functions. The innovation may move to another organisation after completion of certain functions in the earlier organisations.

<u>Hypothesis 1</u>: Mega innovations in multi organisational settings would proceed in clearly distinguishable phase, namely the development phase, the adoption phase and the implementation

phase. In each of the phases, a number of innovation functions would be executed. Majority of the activities during a phase will take place in a particular organisation.

### 2.11.3. Innovation characteristics

Our study is concerned with significant improvements over existing devices. They are really not 'de novo'. Secondly the entire process is funded by the government, which has as one of its objective creation and adoption of scientific techniques. In such a situation, innovation characteristics are not likely to explain either the time taken for completion of the process or the adoption behaviour. Even in the cases of commercial innovations, Klein and Tornatzky found that organisational variables, in addition to the characteristics of innovation, determine the adoption behaviour.

Hypothesis 2: Innovation characteristics alone may not explain either the duration of the innovation process or its probability of adoption in the case of mega innovations in multi organisational settings. The organisational decision processes and the strategy employed by actors, may provide a much better explanation of the process.

### 2.11.4. Champions

Innovation in multi organisational settings require people who can handle interface problems and carry communication to various decision makers. They have to execute a number of functions besides enabling information flow. These functions include influencing decision making in organisation, building

supporting coalitions, removing barriers, educating manufacturer and user, and mobilising resources. Since the innovation process happen to flow through a number of organisations, each with its own structure, process and resources, it may not be possible for a single individual to carry out all these rules. A number of champions may be necessary. The literature has also identified that existence of champions is positively correlated with the success of innovation.

Hypothesis 3: Champions are essential for the success of innovations. More than one champion is likely to be involved in each case.

**2.11.5. Strategy of champions**

The innovation literature does not give any insight into the strategies champions use while promoting an innovation. The characteristics of champions as identified in the literature include, high risk taking ability, initiating more influence attempts, persistence and inspirational leadership. In short the qualities required for an entrepreneur. It is likely that these champions will function as entrepreneurs.

Hypothesis 4: Champion may use an entrepreneurial strategy to further the problem of innovation.

These are the only hypotheses we could formulate using information available from the literature and extrapolating them to our situation. The literature does not throw any light on changes in the characteristics of innovation as it proceeds along or the networking of various organisations. These two are important issues in our study, in addition to the issues mentioned above.

# CHAPTER III

# METHODOLOGY

## 3.1. The Methods of Case Study

Logical explanation of the phenomenon is the objective of scientific research. An understanding of events and causal connection between them help in management and control of the phenomenon. Any research study is expected to fulfill certain requirements. They are:

(1) The study should aid in advancement of the understanding, to enable better prediction.

(2) It should not be a simple explanation of critical events in a post-hoc fashion.

(3) The methods used in the study should be reliable and replicatable.

(4) The parameters identified for observation should be "measurable".

Methods of "measurements" should be reliable in the sense there must be no significant differences in values if measured by different investigators.

Various research designs are used for the purpose of studies in the areas of general management. There are a few major methodologies represented in the literature;

(1) the abstract speculative theorising with no recourse to empirical data

(2) manipulation of large amounts of secondary data

(3) mathematical model building

(4) simulation in laboratories or by computer

(5) survey research by mass questionnaire or interviews

(6) individual case studies

(7) comparative case studies

However, the methodology used for a particular research problem is chosen using the following criteria:

1. plausibility of using a particular method
2. time and resource available to the researcher
3. kind of precision required

In the area of strategic decision research considerable theory development is still required before it can be tested. Hence, qualitative methodologies would be needed for sometime (Fredrickson, 1983).

Linking appropriate useful constructs and problem solving tools with problems of real world, requires one to deal with the inter-relation between the process of abstraction and interpretation. One of the most widely used method is the attempt to elaborate an useful paradigm that is alternative or complimentary to the received wisdom. In this procedure, the hypothetical statements or models are a priori constructed and such a construct is tested with observation made in the real

life. Based on the observations, such constructs are modified and refined.

The qualitative methods like case studies are not very strong with respect to verification using statistical criteria. However, when the issue itself is not clear-cut and lacks a structure, it becomes difficult to generate testable hypothesis. In addition strategic action in the areas of innovation involves a large number of variables which can hardly be controlled. Hence, statistical verifiable procedures are difficult to adopt.

The conventional scientific approach provides rules for discovery and identification of regularities. It tries to determine the cause and effect relationship between the regularities and proposed mechanisms to test hypothesis. These verifiable experimental methods are mostly used in natural or physical sciences. These methods are inadequate to observe and explain the dynamic world of change. The innovation process is in flux and its purpose is to effect change. The same characteristic may be seen by different actors in this process differently and people act in light of the way they see the reality (their frame of reference). Each actor has his subjective reality. Social reality is the common perception that emerges from the interaction between members of a group and this can be different from any of the subjective realities of the individuals. Hence, in addition to emphasizing the observable regularities in the process, one must also aim the inquiry into understanding the actors. The inquiry should lead to a revelation of factors which

binds the actor to certain perception of reality and to a certain role. Such revelations would then lead to the development of models and theories which can then aim in understanding the processes.

Those who are interested in the study of the process of change claim that methods founded on the positivist principles cannot adequately explain the process. Nicolas-Georgescu Rogen in his essay, Measure, Quality and Optimum Scale (Georgescu Rogen, 1976) has demonstrated that the relationship between "quantified" qualities and real qualities are never linear and there would always be a qualitative residual left when one deals with "thinking" matter.

Case studies lead to more complete description and analysis of process dynamics. It is easier to trace the history of change in a descriptive format. Finally case studies can take care of accidents and perturbation which are crucial in determining the path of the process. For instance, there may be a chance meeting that can change the perception of the decision maker (Mody A, 1989).

Borrowing from his experience from clinical psychology, Richard Normann proposes a hermeneutical approach in studying the process of change. He maintains that it is essential to understand an actor operating in a system that he wants to change and the way he improves his ability to deal with his situation. His research method has the following stages:

(a) understanding the actor - through dialogue at equal level - the dialogue is entirely in the language of the actor;

(b) explanation of such behaviour, from accepted theory. If explanation is not possible from theory, attempt at formulating some hypothesis using

(c) historical explanation, whole reconstruction of the process.

Normann also supports the role of in-depth case studies but would prefer understanding rather than mere observation (Normann R, 1977).

In this study we are not attempting to test a number theories which are part of received wisdom. Our focus is on alliance of champions, evolution of a strategy by them and how they implement their strategy. We have seen in the review of current literature, no testable hypothesis exist regarding interplay of champions, their strategy and the innovation process. Our attempt in this study would be to develop some understanding regarding promotion of innovations by champion in developing countries. Case study method as discussed above would be the best suitable approach for this task.

## 3.2. Choice of the Cases

We have seen earlier that organisational features do influence the progress of innovation. Since our focus is on champions and their strategy, we must keep variations among

organisational features to the minimum so that any differences observed between cases are mainly due to the activities of champions. We have also seen that in the cases of third world countries, different organisations are responsible for different stages. It would be quite difficult to match organisational characteristics of the organisation responsible for a particular stage, across cases. These organisational differences are kept to the minimum by choosing cases in which the design and development phase took place in the same organisation. Similarly the adopting organisation was chosen to be government departments or organisations in the government sector. In three of the five cases to be presented, the adopting organisation was the same department.

In developing countries research and development is carried out in specialised research laboratories or in specialised academic institutes. The structure of an academic institute and the autonomy therein encourages emergence of champions. We have picked up cases where the development work was carried out in the same academic institute.

Innovation characteristics do influence the course of the innovations. It is impossible to match these characteristics across all cases. It has been tried to keep the differences to the minimum. All the cases chosen are not de novo attempts. They are either improvements or redesign of existing products or a new use. All the products were to be disseminated in government programmes at almost no cost to the user. The innovations are so

chosen that they had a potential to affect livelihood of very large percentage of population. This was kept in mind as government organisations normally look for very large impact.

Keeping these aspects in mind, five innovations emerging out of a single institute of science (Vigyan) over the decade of 1975-85 were chosen. These innovations got adopted and implemented in various government programmes by 1990. The chosen innovations are:

1. New efficient wood burning cookstoves for homes using wood as fuel
2. Deep well handpump to provide drinking water from very deep borewells
3. A woodgasifier to run diesel engine pumpset
4. Low cost building technologies
5. High purity silicon for solar photovoltaic manufacture

As can be seen, the first four innovations could be used by a very large number of households, especially in rural India. High purity silicon cannot be directly used by rural households but solar photovoltaic panels made from them can be used in large numbers in villages for lighting. Three of the five cases, namely, cook stove, wood gasifier and silicon are in the area of exploitation of renewable energy and were looked after by a single department of the federal government.

### 3.3. The Work Content

Each of these cases took between four and ten years for the completion of innovation process. During this time a number of

organisations, namely research funding agency, institute of science, manufacturers, government departments and agencies were involved. There were large amount of communication in meetings as well as outside between individuals drawn from these organisations. Record of discussions, letters and other correspondence, reports and notes were maintained in files in each organisation.

As a first step these files were procured from the organisations and individuals. On an average each case had at least 200 pages of documentation (excluding technical reports) chartering the course of these innovations. Most of the documentations were maintained by research funding organisations and by innovators. Based on these files, a detailed historical account of the innovation was drawn up. Participating individuals including innovators were contacted to fill in any identified gap in the narration. The draft cases were then circulated to innovators and officers from adopting organisation. They were requested to identify any factual inaccuracies. Discussions were also held with others involved in the course of the innovation to verify all the facts. The cases were finalised based on these discussions. At no point of time the persons were asked to explain reasons for their behaviour. They were clearly told that the exercise is not about the question 'why', but merely interested in how the processes went along. This process took almost 500 hours of the researcher's time spread over 18 months, after the documentation and files were procured. Considerable

time was spent in locating and perusing these files, especially those from adopting organisation.

Once the cases were ready, the analysis was done by this researcher. The case was first analysed to identify the innovation functions. The location where these functions were carried out and the actors were noted. The phases of the innovation process, their duration and the organisation where they occurred were identified. This analysis led to the happening of significant events.

Each significant event, be it a research funding decision, or an evaluation or an adoption was looked into in a greater detail. The individuals who contributed to these events and their role were analysed. The decision processes were inferred, from the data on meetings and from various proceedings. This led to delineation of the strategy used by the individuals.

Champions among various actors were identified essentially by analysing the action of various individuals and their persistent efforts towards promotion of innovation.

Each case was analysed using the following elements: champions, their strategies, creation of networks and the organisational decision process.

Certain issues, especially the evolution of strategies, were discussed with the innovators and champions to understand the logic of their action. Since the analysis was mainly concerned with explaining the 'how' of the process and not the

'why' of it, there was no in-depth interviews with actor on their behaviour.

Since most of the documentation regarding these cases are not still released to the public domain by the concerned organisations, and since some of the individuals requested for anonymity, the identify of individuals and organisations have been disguised in the presentation of cases to follow in the next chapter.

# CHAPTER IV

# CASES AND ANALYSES

## 4.1. HOSA OLE - AN EFFICIENT, SMOKELESS, WOOD BURNING COOK STOVE

### 4.1.1. The Jaggery Stove

Farmers of a district in the PS province, traditionally were making liquid jaggery from the sugarcane they were cultivating, using wood as fuel. The district had a large area under forest. The farmers of the district were not using sugarcane bagasse as fuel for making this liquid jaggery. This was primarily due to low percentage of sugar in the sugarcane which they were cultivating. This in turn required evaporation of larger quantity of water from the juice, for which task the bagasse was not sufficient. Besides they had no problem in obtaining the wood required for making liquid jaggery. They could not make solid jaggery because juice was acidic in nature and hence could not caramelise.

Dr. SH, an Assistant Professor at the Institute of Science (Vigyan), hailed from this district and was aware of the problems pertaining to the making of the liquid jaggery. During late 70's, the Government of the PS province put a ban on felling of trees in the forests of district which affected the production of liquid jaggery drastically. Dr. SH posed this problem of making liquid jaggery to Prof. RK and Prof. SL of the Chemical Engg. Dept. of the Vigyan. Prof. RK and Prof. SL were also members of

the Department for Rural Technology (DRT). Prof. RK and Prof. SL visited a village in the district on 16 February 1980 and studied the problem at first quarters. They felt that they should be able to design an efficient bagasse burning stove to make liquid jaggery. They also told the farmers to boil the juice with addition of slaked lime water if they wanted to obtain solid jaggery. They felt that they could use only bagasse and hence completely eliminate the use of firewood. They sent a proposal to the Council for Science and Technology in the PS province (CST) seeking Rs.20,000/- and a time duration of 6 months for this project. A member of the Executive Committee of the CST felt that this work is not necessary as farmers elsewhere in the province used bagasse and what was needed was a visit by the farmers of this district to other areas. It was brought to his notice that the amount of water in the sugarcane juice in the district was quite large and even the traditional bagasse burning stoves used by farmers elsewhere in the country would not be able to evaporate all that water. Since the amount involved in this project was small, and the benefits that are likely to occur were large, the Executive Committee of the CST approved the proposal. Prof. RK and Prof. SL designed and constructed a three-pan jaggery making stove of efficiency higher than 50% and demonstrated to the villagers in the next crushing season in November 1980. The farmers of the district adopted this design and very quickly more than 20 such stoves were installed using funds available with the District Rural Development Society.

### 4.1.2. The Development of Cook Stove, Hosa Ole

Prof. RK and Prof. SL modeled the performance of this jaggery stove and simulated the model for various dimensions. They found that scaling down this design to the level of a household would give rise to very efficient domestic cooking stoves. They borrowed an engineer from another CST project and continued the project on development of domestic cook stoves. An earlier study conducted in 1976 in the villages in another district by DRT showed that nearly 80% of the energy consumption in rural areas were for cooking at homes and the dominant fuel was firewood. Laboratory tests using the model developed by Prof. RK and Prof. SL showed very high efficiency of the order of 45%. They took help of Prof. SJ, a Civil Engineer to finalise the design details of this stove and by 1982, they were able to demonstrate that a stove which is smokeless, which can simultaneously cook on three pots, and had an overall efficiency of 45% could be built. They wanted to field test this stove by building 200 such stoves in villages around 'Ring' where DRT had set up an extension centre. They sent a proposal to the federal department of Science and Technology, for field trial of this particular stove.

### 4.1.3. Another Stove (Agni) from Another Institute

A department for science and technology was set up in PS province in November 1981. Right from the beginning, the department was looking for devices to reduce energy consumption at homes. A professor of the Vigyan became the Additional

Secretary of the DST on deputation and hence was in constant touch with developments in research laboratories. In 1981, the Power Research Institute (PRI) also located at the headquarters of PS province announced the development of portable single pan, efficient stove named Agni. An entrepreneur, an automobile engineer by training and was running an automobile workshop, showed interest in this technology and obtained a license to manufacture these stoves from PRI. He set about promoting these stoves under government programmes as he felt some subsidies were necessary. He approached the Dept.of Science and Technology and Dept. of Rural Development of PS province for help. The Govt. of PS province wanted this stove to be tested by the Vigyan. The request of the Government was referred to Prof. RK, who declined to test the 'Agni' stove stating that he himself was developing a stove and hence his opinion would be biased. He suggested to the Government that they could accept the results as provided by the PRI itself and decide on the propagation of the stove. The test results provided by the PRI showed that the stove performed with an efficiency ranging between 25-35%. The rural development department of PS province purchased a few such stoves and distributed to households near the head quarter city. However the stove did not get adequate acceptance by the user. The users felt that the stove took more time to cook than the conventional stoves and the stove was smoky initially. They all accepted that the stove did reduce fuel consumption to some extent. No further progress could be made on propagation of Agni because the portable stove had no means by which the smoke could be sucked

out of the stove and release outside the house.

There was change of personnel at the helm of affairs in the Department of Science & Technology of PS state in 1983.

### 4.1.4. Adoption of Hosa Ole in the PS Province

In the meanwhile, Dr. SH who had been following development at Vigyan closely, built one stove of Vigyan design in his house in his village during early 1983. He closely monitored its performance in his house at the village for a period of 6 months and found out that the amount of fuel and time required to cook a meal could be reduced enormously. He built a few more stoves in his village for his friends. This could be done by him using his own funds as the cost of a stove was only around Rs.100/-. The Yuvaka Mandali of the village of which Dr. SH and his school teacher brother were key members, took interest in the stove and wanted to get their members trained so that they could go ahead and build the stoves all over the district and may be in other districts. The Yuvaka Mandali sent a proposal to the Department of Science and Technology, Government of PS province. This stove was also demonstrated to the members of the Council for Science & Technology during the Annual General Meeting of that year. The new Secretary of the DST, Govt.of PS province, Mr. VB who was also Secretary to the Chief Minister at that time took a keen interest in this stove and hence was favourable to consider the request of Yuvaka Mandali.

The Yuvaka Mandali in their proposal to the Government,

brought to the notice that the stove designed by DRT, Vigyan, which they named as Hosa Ole (New stove) eliminated the problem of smoke because it uses the chimney. Since it had three pots to cook, the cooking time got reduced considerably and the laboratory efficiency of these stoves were between 40-45%. Since the stove was constructed in situ using mud and bricks with a few bought out components, it gave raise to some local employment. The Government asked the Yuvaka Mandali whether they would be willing to organise this training programme through the CST and whether they have got assurance from DRT that the technology would be transferred to them. Dr. SH who was also a member of DRT told the Government that DRT would not have any hesitation in training the volunteers of Yuvaka Mandali. He did not consult the Chairman of DRT or the members of the stove team. The Yuvaka Mandali also agreed to the government's proposal that the training programmes shall be organised through the CST. Hence the PS provincial government issued an order on 31 December 1983 for transfer of funds to the Council for Science & Technology to organise training programme in stove construction. A copy of the order was also sent to the Chairman, DRT.

The Chairman, DRT, (Prof. SJ) did not want to assist the Yuvaka Mandali by providing them with training as he and the members of the stove research team felt that it was bit pre-mature. They told Dr. SH that they had not yet field tested the stove and hence are not sure of acceptance level by the public. However Dr. SH told the stove team that based on the stoves that

he has constructed, there was a tremendous demand for these stoves from the villagers and he felt any further delay in meeting their request would discredit DRT. Besides, non-implementation of Government Order would also expose DRT to the criticism that they are not willing to help the government. DRT decided to go ahead with the training programme. There was also a minor irritant between Dr. SH and the innovators. Dr. SH had, in the stoves constructed by him, used a brick to close the port from which the ash is removed. The innovators had used a hinged, metal door for this purpose. The innovators felt that the housewife is sure to misplace and loose the brick. An uncovered ash port would reduce the efficiency by some extent. Though they requested Dr. SH not to use the brick, they did not take more efforts to stop the practice.

Dr. SH had also tied up with a non-governmental organisation in another town to conduct training programme there. Similarly DRT wanted to conduct a training programme in 'Ring' village. Mr. VB felt that this stove should be spread all over the state and hence wanted that atleast a few persons from every district is exposed to the construction of this stove during these training programmes. He organised a meeting of the Deputy Commissioners of all the districts on 9.1.1984 at the Administrative Training Institute. He requested Dr. SH to make a presentation to these deputy commissioners. At this meeting it was decided that the deputy commissioner of the respective districts will send two persons for training at these training programmes. It was also decided that the Deputy Commissioners themselves will also visit

during this training programme lasting ten days and would stay atleast for three days along with the trainees. It was further decided that other districts should take up a massive scheme for construction of Hosaole. It was decided that the scheduled caste and scheduled tribe households should be covered in the first instance. The cost of the 'hosaole' was around Rs.100/-.

The three training programmes were held during February 1984 and in each training programme each person built atleast 5 stoves each in the villages around. The response from the villagers to these stoves were enormous. The Deputy Commissioners of the districts who visited the training programme also showed very keen interest in propagating such device in their respective districts. Hence Govt.of PS province took a decision to prepare a scheme for massive adaptation of this stove.

**4.1.5. Adoption of Stove in the Federal Programme**

Mr. VB worked out a project proposal to propagate this stove at the rate of 1,00,000 stoves per year. To build so many stoves, it required about 500 trained artisans. It was then decided that the CST should train about 20 instructors who would be posted to the district at the rate of 1 instructor per district. They would then organise a training programme in each taluka. Though 3 trained artisans per taluka would be sufficient to build about 1 lakh stoves, it was decided to train atleast 15 persons from each taluka. The finances involved ran into nearly one and a half crore rupees per year and the provincial government started

looking for finance from the federal government for this programme.

At the time the DST of the PS province came to k?know ??from the Rural Development & Panchayat Raj department of the province that the federal department in charge of energy (DFG) which had been set up around that time, was launching a National Programme on Improved Stoves. Mr. VB met the Joint Secretary (who was his batchmate in the administrative service), found out the details of this programme. Under this programme, the rural development department of the PS government would be the nodal implementing department. The DFG provided financial assistance for both training programmes as well as construction of stoves. They told Mr. VB that they had already approved a few stoves developed elsewhere in the country as well as 'Agni' for construction/popularization under this programme. Mr. VB requested them to consider approval of the 'Hosa Ole' as it had very high efficiency, was smokeless and reduced cooking time. The DFG informed him that the stove had to be tested either at the PRI or at national institute of technology (NIT), the two recognised testing centres for the department. Accordingly, the stoves were built at the PRI and was tested by the PRI on a request from the provincial government. The test results showed that the stove could attain an efficiency of 44.3%. and a certificate was issued on 14 June 1984 by PRI certifying that the stove performed excellently. The Dept.of Rural Development & Panchayat Raj (RDPR) of PS state was requested by Mr. VB to forward the proposal prepared by CST from their department along

with this certificate. Accordingly a 4-member team with Prof. RK, Deputy Secretary, DST of PS province, Deputy Secretary, RDPR and Joint Secretary, CST, went to Delhi in June 1984. During the discussion with the Joint Secretary of DFG, the DFG informed that the stove has highest efficiency of all the stoves that had been developed in the country, but was also the costliest one. They felt that the cost could be reduced by sacrificing, if need be, a bit of efficiency. DFG representative pointed out that one could remove some components like steel door so that the price of the stove could be brought down. It was pointed out that such ad hoc removal of components might lead to a reduction in the efficiency. The removal of the steel door itself will reduce the efficiency by 6 percentage points. Later on, Mr. VB informally informed the DFG that the decision of the Govt.of PS province is final and would not like to alter the design of the stove to reduce its cost. It was mentioned that in the event the DFG does not approve this programme, the government of PS state would any way go ahead with its propagation. An article also appeared in all editions of a national newspaper, accusing that the DFG was trying to influence the decision of the provincial government. The article written by a staff of the newspaper, had sourced the information to another member of DRT, Vigyan, who had the knowledge of these developments. But he was not directly associated with the programme.

The stand of Govt.of PS state and the fact that the Vigyan, a premier institution was involved in the design of the stove led

to approval of the stove under the National Programme on Improved Stoves. Funds for the national programme was released by DFG to the Dept.of Rural Development and Panchayat Raj which in turn released the funds required for training to the CST.

#### 4.1.6. Implementation of the Innovation

The implementation of the programme was carefully structured by Mr. VB. The DRDS in each district was chosen to be the nodal implementing agency. In each block the block development officers (BDOs), who directly report to DRDS was made responsible. They in turn used gramsevaks under them to identify the users. The users have to arrange for mud and bricks and also pay a nominal sum to the artisans constructing the stove. All other components like chimney, metal doors were arranged by the DRDS.

The DRDS was responsible for (a) procuring all components, inspecting them and delivering them to BDOs, (b) random inspection of the stoves constructed to ensure quality and (c) to organise training programme at the rate of one per block. They had at their disposal the services of the instructor trained and sent by the CST. The BDOs were in turn responsible for (a) choosing the artisans to be trained, (b) employing trained artisans to construct stoves and (c) to make available the prefabricated components at the doorsteps of chosen??n users to enable construction and (d) inspection of constructed stoves and making payments to artisans. They did not have any full time

person to carry out these tasks and they used their other

engineering staff for this purpose.

The CST was made responsible for (a) recruiting instructors and training them, (b) transfer of design of prefabricated components to small entrepreneurs, (c) inspection and approval of these manufacturers and (d) provision of any technical backup that may be required by DRDS. The RDPR department at the provincial level, liaisoned with DFG. The funds procured from the DFG was sent to DRDS and to CST by RDPR for their respective tasks. It also acted as an office to consolidate reports for DRDS and CST and pass them onto DFG. The responsibility for coordination and implementation was given to DRDS.

During July 1984, a massive training programme cum construction programme of this stove was launched and in the next four years, nearly 300,000 such stoves were installed in the province.

## 4.2. HOSA OLE - ANALYSIS

### 4.2.1. Innovating Stages

This innovation was not a denovo creation. An innovation that was successful for a particular task, namely making jaggery, was scaled down to perform the task of cooking at homes. This could be considered as an extension of the earlier work. There was no attempt by the innovators to evaluate other alternative designs of cook stoves. An important function in the innovation process namely search, and appraisal of earlier solutions was not carried out. The innovation process as presented in the case consists of design, field trial, commitment seeking, incorporation and diffusion. We may note that the design function took almost two years. The jaggery furnace was ready in November 1980 and the cook stove was ready for field trials in late 1982. The field trial phase had not even started when Dr. SH entered the scene as a champion in 1983. Only the few stoves built by him and a few built by innovators for experimentation constituted the field trial. The functions of commitment seeking and incorporation into regular government programmes started in August 1983 and was over in about 10 months. The reason for such quick progression lay in the functioning of champions.

### 4.2.2. Champions of Innovation

Undoubtedly Dr. SH emerges as a champion of the innovation. He brought to the notice of the innovators the problem faced by liquid jaggery makers of his native district. When the prototype

of the cook stove was ready, he named it Hosa ole and took all efforts in promoting it. He approached the department of science and technology of PS province with a proposal from the Yuvaka Mandali. He went along with Mr. VB to the meeting of the deputy commissioners to convince them of the qualities of the stove. When he was sure that the commitment of the government has been secured, he withdrew from the scene, so that the innovators, CST and Mr. VB could put together a programme. He had initiated all the influence attempts. He took a risk in promoting an innovation that had not been extensively field tested. A few stoves that he himself had built, gave him the confidence.

Another champion of this innovation was Mr. VB, then Secretary to the DST of PS province as well as secretary to the Chief Minister. Dr. SH convinced him of the usefulness of the Hosa ole. Then Mr. VB he did not leave any stone unturned to disseminate the innovation in large numbers. Using the meager funds available in his department, he initiated the first 3 training programmes proposed by Yuvak Mandali. He also made the Deputy Commissioners of DRDS, who were likely to be key figures in the dissemination programme, attend these training programmes. Though the DFG had already approved a few other designs under the national programme of improved stoves, from which the provincial government could have chosen a design, he used his influence with the nodal RDPR department to make a proposal to DFG to include Hosa Ole. When suggestion for modification to reduce cost were turned down by innovators, he stood by them and made the

commitment of the provincial government known to DFG. He initiated and established a network of DRDS, Vigyan, CST and RDPR to implement the programme. He exhibited a high risk taking ability by proposing to build 100,000 stoves in the first year itself, when no field testing of the stove had been done. He was proactive by initiating a number of influence attempts.

#### 4.2.3. Alliance of Champions

Though Dr. SH and Mr. VB were champions of@Hosa Ole, they did not act together as an alliance of champions. The role of Dr. SH ended with convincing Mr. VB of the qualities of innovation and securing the governmental grant through CST for Yuvaka mandali to conduct the training programmes. Mr. VB became the champion then onwards and played his role till the network was established to implement the dissemination programme. Neither the innovators nor the CST acted as champions. They cooperated with Mr. VB. For a brief period, from August 1983 when Mr. VB saw a demonstration at the CST to February 1984 when the yuvaka mandali proposed training programme commenced, Dr. SH and Mr. VB were in contact with each other. Dr. SH made a presentation to the Deputy Commissioners at a meeting organised by Mr. VB.

#### 4.2.4. Strategy of Dissemination

It is not clear whether the innovators had any strategy for dissemination. They had planned for a field trial and had sought funds for it. However Dr. SH who was not an innovator had made up his mind to seek government sponsorship. He mainly relied on the

technical characteristics of the stove, namely higher efficiency, smokelessness and faster cooking, to win over commitment from the provincial government. Fortunately for him, Mr. VB, who as the Secretary of PS provincial DST had the mandate for disseminating the new technology, quickly decided to play the role of a champion.

It would be interesting to look at the elements of strategy used by Mr. VB to get the Hosa Ole incorporated in the national programme of improved stoves. His department was not the nodal department at the provincial level for implementing the national programme. He got the Rural Development and Panchayat Raj (RDPR) department, which was the nodal department to propose Hosa Ole formally to DFG. It was pretty clear, once proposed, Hosa Ole would get the approval as it had an efficiency higher than the stoves already approved. He used his friendship with a joint secretary in DFG to expedite this approval. He stood by the innovator group in rejecting suggestions for modifications in the design. He took a great risk in informing DFG that even if DFG did not approve the Hosa Ole, the state government would however go ahead. His department's budget would just not have been sufficient for undertaking this programme if DFG had indeed not approved Hosa Ole. This was a gamble to put pressure on DFG. The article in the press, which was not contradicted, added further pressure on DFG. The next step was to plan and put in place, a network, though informal, to ensure the dissemination. In planning the dissemination, he planned for a very large number of 100,000 in the first year itself. He knew that funds from DFG

would be available for such large numbers. Rapid growth was an important objective. The strategy was made up of moves initiated by Mr. VB, to search for and secure opportunities for the dissemination of Hosa Ole. The power to initiate?ate and control the moves rested in the person of Mr. VB. It is very clear that Mr. VB acted as a venture entrepreneur and the strategy was made in an entrepreneurial mode.

It may be worthwhile to look at the decision making process at the DFG. It has been well established that bureaucracies normally adopted an adaptive, satisficing approach to decision making. This is characterised by (a) definition of acceptable performance, (b) standard operation procedure, (c) uncertainty avoidance and (d) search for solution in the neighborhood. The DFG had fixed certain minimum efficiency as the criteria for acceptance of designs. A standard procedure for certifying was also evolved. But when they found the cost of Hosa Ole much higher, they had no set procedure to deal with this. Hence the suggestion for reduction of cost; they did not suggest to PS province to look at other designs. It is very clear that the decision making procedure was based on the normal organisational process exhibiting adaptive, satisficing behaviour.

An entrepreneurial dissemination strategy, then is likely to influence an adaptive decision making behaviour by initiating a number of influence attempts and increasing the pressure on the organisational process.

### 4.2.5. Changes in the Characteristics of the Innovation

The innovators had worked on the design parameters in such a way to maximise the efficiency. They had arrived at a design that had provided the highest efficiency among all designs. Naturally they liked to safeguard this pre-eminent position. Saving of fuel was the single important objective. However there were suggestions to change a few design details in order to reduce cost. Dr. SH used a brick instead of a hinged door to close the ash port. DFG suggested removal of the metal door of the fuel wood box. The suggestion, by Dr. SH, did not reduce the efficiency. However there was a danger of housewives losing the brick or not using it which would then reduce the efficiency. The suggestion by DFG, led to reduction of efficiency. Both were not accepted. The efficiency was the core characteristics on which no compromise could be made. Another reason for this rigid stand would have been the strong support extended by Mr. VB. The innovators did not think cost to be a major parameter. The removal of the fuel wood box lid resulted in the reduction of cost by about 15%. The efficiency would have been reduced by 6%. No cost benefit calculation were made. Acceptance of the suggestions meant a modification of their own norms and objectives in designing the stoves. Generally people tend to reject such behaviour that would question their own norms, values and attitudes. In this case a strong state sponsorship and support by a champion (Mr. VB) reinforced their faith in maintaining the efficiency as the sole criterion.

### 4.2.6. Network for Implementation

The dissemination of Hosa Ole required a number of tasks to be performed in a coordinated manner. The design drawings of prefabricated components had to be transferred to identified entrepreneur, the quality of their products checked, production and delivery of them ensured. Artisans had to be chosen and trained in the construction of Hosa Ole. The District Rural Development Society (DRDS) which was completely under the control of RDPR department and headed by the deputy commissioner, was to take on the responsibility at the district level. DRDS's links with Block Development Officer and further down to grama sevaks was to be used. The proposal drafted by Mr. VB envisaged an informal network consisting of RDPR, DRDS, CST, manufacturers, BDOs and trained artisans. His own department had no role. There was no coordinating committee to oversee the functions of the members. The entire network consisted of bilateral arrangements. It could be visualised as depicted in Figure 4.1.

Since the role of each organization was clearly defined, and the procedure for flow of funds, material, trained manpower established, there was no need for a formal network leader. RDPR was providing funds and took care of administrative difficulties. The CST was made the technical backup unit to sort out any technology problems. The network was governed by the bilateral agreements entered into by member organisations.

#### 4.2.7. Multilocational Development of Similar Innovations

A number of research groups in the country were attempting to develop improved cook stoves. Even in the PS province, the Power Research Institute developed a portable metallic stove 'Agni' and the Vigyan group 'Hosa Ole'. The DFG had by 1984 approved some designs from other research groups. We must note that these were hardly any communication between research groups. When the PS provincial government requested Vigyan to evaluate 'Agni' they desisted from doing so. The groups have behaved more or less as competitors.

The DFG set the standards of efficiency at a level where most of the designs would be approved. There has been no clear cut comparative assessment of various designs. The choice of a particular design to be incorporated in the programme was left to provincial governments. This gave enough opportunity for champions to promote their designs. We must note that in the PS province, a few hundreds of 'agni' was given to users and rejected due to the non-acceptance. No such trials were done for Hosa Ole. A massive programme to build 100,000 stoves was launched. Hosa Ole had other advantages of smokelessness, quicker cooking and creation of jobs in rural areas besides very high efficiency. Hence it was a natural choice. But no comparison of Hosa Ole with other cheaper mud stoves (already approved by DFG) were made. No cost benefit analysis was done. Multi locational development then, does not prevent the champions promoting their product.

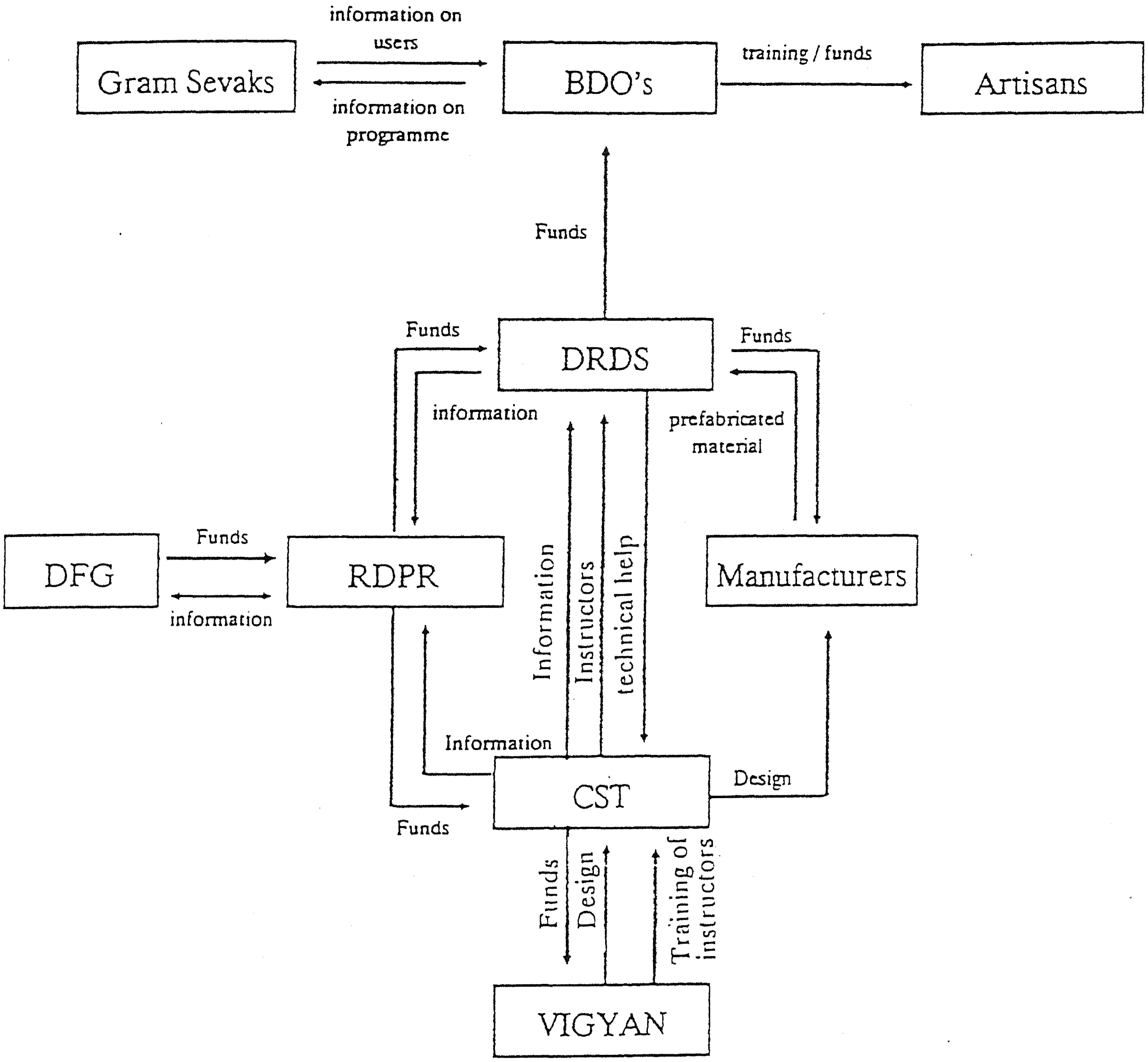


Figure 4.1: Network for diffussion of Hosa Ole

In conclusion, the Hosa Ole got disseminated under a government sponsored programme, entirely due to the efforts of champions Dr. SH and Mr. VB, who used an entrepreneurial strategy to seek commitment from the sponsor, DFG. The innovators and their sponsors, CST, played a supporting role.

## 4.3. THE DEEP WELL HAND PUMP

### 4.3.1. Identification of the Problem

It was in 1975 that some ministers, administrators and scientists in a province (PS) came together to form an autonomous registered society, the Council for Science and Technology (CST). It was their firm belief that development and use of appropriate technology would greatly enhance the quality of developmental process. To ensure that such technologies are developed, the Council in its bodies gave equal representation to both policy makers and scientists/engineers. For example, its Executive Committee, chaired by the Director of a major institute of science (Vigyan) had 6 government representatives (Chief Secretary, Additional Chief Secretary, Finance Commissioner, Development Commissioner, Commissioner for Science and Technology and Finance Minister) and 6 eminent scientists/engineers. The Council also believed, that in every project, the users of technology and the developers should be constantly interacting right from the initiation. For this purpose working groups were set up for each project by the Council.

In the very first meeting of the Executive Committee on 9 September 1975, the then Finance Minister raised the issue of non-performing hand pumps. Hand operated pumps fitted on to a borewell were the only source of obtaining drinking water in a large number of villages. He said that borewells in the province are deeper and more people use the pumps resulting in frequent repairs. He said, on an average about two third of the handpumps

did not work on any given day. He wanted the Council to look into this issue. After some discussions at the secretariat of the Council, Dr. GR, an Asst.Professor, Mechanical Engineering Department of Vigyan, was identified to lead the working group as its Convenor.

#### 4.3.2. The Solution Process

On 20 October 1975 Dr. GR and the secretariat of CST agreed that the project should concern itself with technical improvements in the handpumps used for drawing water. On 22 October 1975 the Chairman of the Executive Committee of CST requested the government to nominate Mr. HR, an Executive Engineer, Public Health Engineering Department (PHED) as a member of the Working Group. The PHE department was the department entrusted with the task of drilling wells, installing and maintaining hand pumps. Hence they would be the users of the solution. On 24 November 1975 Dr. GR and his team was asked to submit a budgetary proposal. On 25 November 1975, the Chief Secretary, PS province, directed the PHE department to allow Mr. HR's participation. On 28 November 1975 Mr. HR informed that he is going on a three month World Health Organisation fellowship and handed over some documents pertaining to some developments that had taken place at the PHED regarding the hand pump. Dr. GR submitted a proposal to the CST (duration 18 months, budget Rs.45,000/-). He wanted to concentrate simultaneously on failure mode analysis as well as development of a new pump. The Chief Engineer, PHED instructed all their field officers to extend full

cooperation to the Working Group during field visits. On 31 January 1976 Mr. KNS, another Executive Engineer, PHED joined the Working Group in place of Mr. HR. The Working Group spent January and February 1976 visiting various hand pumps. It found out that handpumps were installed under various programmes like Community Development, UNF programme, Famine Relief and National Rural Water Scheme. On Feb. 1, 1976, the budget was approved and the project formally began. The Working Group prepared a format of survey and requested PHED to collect information on <u>all</u> handpumps. However after three months it was found that the data received from PHED was inadequate. The Secretariat of CST sought the help of Development Commissioner (a member of the Executive Committee), to whom the PHED reports to, to arrange for the required information. The first interim report was submitted on 9 June 1976. 1,554 pumps had been installed till 1974. The target for 5th five year (1974-79) plan was 5,147 handpumps at a cost of Rs.5 crores. The rate of failure was 40%. The Working Group narrowed down its objective to study failure patterns and to suggest improvements in design, manufacture and maintenance procedures. However it did not rule out generating totally a new design based on oscillating liquid column principle. Accelerated testing of current models was to be taken up at Vigyan.

A major change in the project occurred when the Convenor Dr. GR resigned from the Vigyan. On 17 November 1976 he submitted a draft report from his new organisation at Delhi. On 18 November 1976, Prof. RP, a hydraulics specialist in Civil Engineering

Department took over as Convenor. On 20 Nov.76 he convened an informal working group meeting at the CST secretariat, in which only scientist members of the working group participated. At this meeting it was decided to induce National Standard Organisation, NSO to develop a standard. A draft standard was to be prepared by this working group. The working group also decided to classify repairs based on technicalities involved and also identify who can deal with such repairs. The group decided to concentrate only on improvements and jettisoned the idea of a new pump, since the effort needed to operate a model that was built was higher. No attempt was made to see if the model could be improved.

By the end of November 1976, the working group had finalised some modifications. They included introduction of spring washers in between couplings of plunger rod, and introduction of lock nuts. The Working Group wanted these simple modifications be tried out both in the lab and in the field. A meeting with officers of PHED was requested for. On 21 January 1977 a report was released at the meeting. This report highlighted the failure modes and their relative frequencies. (Uncoupling of plunger rods 64%, wear in pivot 18%, malfunctioning of leather buckets 11%, disconnection of riser pipes 7%). Simple improvements costing less than Rs.10/- per pump could drastically alter the situation.

#### 4.3.3. Adoption of Simple Improvements Suggested by Vigyan

Meeting was held on 21.1.1977. Mr. SAK of PHE (formally with UN organisation, [UNF] stores at Bombay) and other PHED officers

attended. They suggested alternatives for plunger rod itself, like wire rope, nylon or PVC rods. Neoprene buckets were suggested instead of leather buckets. It was pointed out that (a) these were not readily available, (b) it would take some effort to induce manufacturers to switch over and (c) they would be costly. It was agreed inexpensive modifications as suggested would be tried out.

### 4.3.4. Developments at RAC

There was a conference on drinking water organised by the PHE department of PS province in collaboration with the United Nations Organisation (UNF) in 1976. At this conference PHE department presented a note on the developments that have taken place in PS province. Around that time, Mr. TSK had taken over as the Managing Director of RAC Ltd., a loss making, large scale engineering firm of the federal government. He was looking for areas for diversification and also areas for fulfillment of social obligation. He had identified drinking water as one area that should be explored. He had sent the General Manager of a plant of RAC, Mr. KS and Mr. M, a mechanical engineer to this conference. At this conference they announced that RAC would take on the responsibility of designing and developing a reliable and simple hand pump at their own cost and wanted the cooperation of UNF and other government agencies in developing and field testing such a design. They got in touch with the central public health and environment engineering Organisation (CPHED), a wing of Ministry of Works & Housing of the central government and a

relationship was established with Mr. VG, head of CPHED. CPHED was guiding various state governments in rural water supply programme and also providing financial assistance. Mr. VG suggested RAC to make use of mechanical R&D, a Govt.of India's research lab for help in engineering design. RAC took the help of mechanical R&D in getting the engineering designs verified. UNF also participated in the development work by evaluating designs and arranging for field trials.

### 4.3.5. UNF and CST Interaction

UNF which was assisting various states in the drinking water programme wanted to meet the working group at CST. A meeting was fixed on 3 March 1977 in which Mr. MD and Mr. RT of the UNF participated. Mr. RT informed that UNF is interested in quality control, norms for testing hand pumps, repair procedures and development of new repair wrenches. He also informed that a new top head, Mark II, (top head which is not connected to casing pipe) has been developed at RAC and 12 of them are working satisfactorily in a district in another province. The working group felt that basic problems of uncoupling of the plunger rods would not be reduced, by an improvement in the top head. They provided to UNF all the details of the modifications suggested to the PS government.

Mr. RT of the UNF informed in May 1977 about the progress made at RAC, on Mark II. He visited the CST and met Prof. RP and others. On 30 June 1977, he sent Mark II installation note. He

wanted information from Prof. RP's group on plunger rod and locknuts. UNF was satisfied with the development of the head. They also wanted information on leather buckets. On 4 July 1977 Prof. RP visited RAC and had a detailed discussion. By then RAC had developed some special tools for use in installing in and removing handpumps from borewells.

The CST suggested to another state's PHED which was helping RAC in field tests to try out some of the modifications arrived at Vigyan.

**4.3.6. Progress at PS Province**

PHED incorporated the modifications as suggested, in their procedures, on 27 April 1977. Prof. RP applied for one year extension without additional budget.

On 2 May 1977, Central Leather Laboratories was contacted on the leather buckets but the reply was not satisfactory.

It was found out that the leather buckets swell in water and introduce lot of friction, which leads to uneven stresses on the parts. But not all leather buckets swell uniformly. It was decided to study swelling characteristics of the leather buckets. The Working Group on 13 September 1977 recommended that leather bucket made only from the butt portion of the buffalo hide must be used. For trial purposes 100 such leather buckets were procured.

During the first week of October, Prof. RP and others visited a number of PHE divisions to find out the quality of

implementation of modifications. They found the quality was tardy, only partial implementation had been effected. The detailed guidelines drafted had not even reached the field in most places. The channels of communication had diluted the message. In spite of all this the performance of the pumps had improved significantly.

On 18 November 1977, the scientists in the Working Group met to discuss the ways and means of improving the communication. Films, workshop for field officers etc. were debated.

In the meantime there was yet another change in PHE department. Mr. S had taken over as Chief Engineer. He was requested to monitor 60 handpumps that were modified. On 16 February 1978, the PHE department submitted a monitoring report. Pumps were found to be working satisfactorily. PHE department suggested continuation of monitoring for another 6 months. Apart from the modifications suggested by Prof. RP, the department had also introduced additional modifications such as universal coupling and removal of one non-return valve.

**4.3.7. Implementation Process**

On 18 February 1978, a meeting presided over by the Revenue Commissioner (Secretary, Rural Development, Chief Engineer, PHE, CST were members) approved incorporation of modifications on <u>all handpumps</u>. Tender document for further purchases would be amended.

On 6 June 1978 a training programme for 125 field level engineers from the northern districts was conducted.

On 16 August 1978, the PS government constituted a committee to fix an expenditure ceiling for maintenance of handpumps. This small committee (4 members) included CST (Prof. RP and another). Prof. RP wanted to study expenditure on maintenance of modified handpumps. He hoped that the mean time between failure would have gone up to 12-18 months.

**4.3.8. The Standardisation Process**

UNF in the mean time had prepared a draft standard and sent it to Prof. RP. This was based on the work at RAC. The PS government took the initiative and constituted a committee for standardisation which included National Standard Organisation (NSO), CST, PHE department. The Development Commissioner called the first meeting.

The CST conducted another workshop for field level engineers. The second one was organised on 19 October 1978. On 18 November 1978 the Standards Committee met and on 29 December 1978 the Convenor of maintenance expenditure committee (a PHE department Executive Engineer) said that he had not received cost feed back from the field and hence suggested winding up of that committee, as the standardisation committee may also look into the maintenance aspect.

On 1 December 1978, NSO prepared a draft standard. This was sent to Prof. RP for comments. On 12 March 1979 the committee on

standards of Government of PS province met and discussed NSO draft. Prof. RP suggested 7 alterations to the draft. The NSO standardisation committee included Mr. S, Chief Engineer, PHE department. Prof. RP and CST stressed the need for a good information system and a well trained local mechanics. They felt standardisation may only ensure a longer mean time between failure, but pump once under repair, can not be rectified for the lack of well trained local manpower. Prof. RP, prepared training manuals in Kannada, conducted two training programmes for local artisans.

During March 1980, in his report, Prof. RP mentioned that NSO has finalised specifications (but not yet published), incorporating <u>most</u> of the recommendations of the CST. He said that on a request from NSO, testing facilities had been set up at Vigyan and one pump from a manufacturer was tested on reference from NSO. He felt that with these standards the mean time between failures would be atleast 18 months. Decay rates of parts have been updated. Reliability of each component need to be improved.

During this time, a number of handpumps were made by RAC and installed for field testing in a district of a neighboring state. A few handpumps were also installed in other states. All these were funded by UNF or CPHED. Based on the study of failures in these, minor modifications were incorporated and they were passed onto NSO. RAC also went about development of small entrepreneurs to supply various parts. Required jigs and fixtures were designed, fabricated and provided free of cost to small

manufacturers.

In September 1980, NSO committee met at Delhi and dropped a major recommendation (Spring-Washer) of Prof. RP but retained the other recommendations including the use of lock nut. It reduced thread length of plunger rod. The NSO committee did not have Prof. RP as a member, though originally it was to have him. But he was invited for the meetings, which he could not attend. The final composition had four manufacturers (including RAC), Govt.of India, Government of PS state (Mr. S of PHED) and UNF. The CST felt that reliability of the final standards would not be significantly higher than the older pumps. A formal proposal to amend the NSO standards back to the earlier one was sent on February 1981 to NSO. But the field trials of Mark II fabricated according to new standards functioned effectively and NSO did not find it necessary to change the standards. It was felt standards could be revised may be after two years.

The Government of PS state stood committed to the pump as per NSO standards, as it had initiated the proceedings in the first place. Besides the UNF was a major funding agency, who wanted acceptance of NSO standards. Hence the government modified all their tenders to suit NSO.

Prof. RP, felt that though modified NSO standard is an improvement over old design, the pump would still not meet with the objective of 18 months mean time between failures. He felt this would be mainly due to some non-standard components like the

leather bucket. Even if the CST's recommendations had been incorporated, the problem of non-standard components like leather buckets would continue. Hence he wanted to design a new pump altogether and was granted finances. During September 1981, he installed four new pumps (force pumps, using only standard plumbing components like non-return valves etc.) in the field. A visit to these sites after 7 months showed that though the pumps were working, the effort needed is much greater. Children found it difficult to operate. Hence the idea was given up.

The Government of PS province decided to go ahead with the Mark II (NSO) pumps and installed nearly 100,000 of them between 1983 and 1986. Looking back at the events, now after a gap of a decade, Prof. RP feels that the Mark II is definitely a major improvement over the earlier pump. In his opinion, this is due to:

(1) the pedestal being encased in a concrete foundation, and structurally not connected to the casing pipe. This reduces the vibration of the pump as a whole and the connecting rod in particular.

(2) the identification of a few selected manufacturers to supply the pump, and introduction of strict quality control measures at the manufacturing level itself. The UNF appointed a British firm specialising in quality control to monitor the quality of manufacture.

## 4.4. THE DEEP WELL HAND PUMP - ANALYSIS

### 4.4.1. Alliance of Champions and Their Role

4.4.1.1. No champion at Vigyan: In this case we see two groups of scientists, one located at Vigyan and the other at the RAC Corporation, developing solutions for essentially same problem, failing handpumps. The group at Vigyan was working for an identified client namely the PHED of the PS province. The nature of interaction between Prof. RP's team and the PHED, though mediated by CST, was a consultant-client relationship. The Vigyan team did not view their work as an innovation resulting in a new product. They were content with changing the design specifications in such a way that the mean time between failure was pushed upto an acceptable level. As with any good consultant, Prof. RP wanted the client, the PHED absorb and implement the solution. The Vigyan group and the CST were willing to provide all assistance - training camps, manuals, standards etc., - to the PHED, and were dismayed at the tardy acceptance.

It is surprising to note that no one in the Vigyan group or the CST saw the work as an opportunity creating innovation, which could be disseminated across all over the world, wherever ground water is tapped. The attempt of UNF to link Vigyan with RAC in this work did not succeed. Failure to grasp such an opportunity indicates the lack of a champion in the Vigyan - CST group. This may be due to the fact that Prof. RP came into this project, after Dr. GR had left. The idea was not his. Originally the

problem was identified byhe government (the Finance Minister) and posed to CST for solution. A strong consultant-client attitude precluded emergence of a champion in Vigyan.

4.4.1.2. <u>Championing by RAC and UNF:</u> Contrary to this development, the general manager of RAC championed the cause of deep well hand pump right from the beginning. Though development of deep well hand pump was not the main line of business for RAC, the enthusiasm showed by Mr. KS, GM of the RAC clearly identifies him as a champion. A major characteristic of a champion is his untiring efforts to seek support and commitment from a wide variety of individuals and organisation. Even before the development work could start at RAC, Mr. KS at the conference of 1976 announced their commitment to develop with their own funds a new deep well hand pump and sought support from all participants.

From the case data, it is quite clear that Mr. RT of UNF also played a championing role in promoting the RAC pump. He initiated a number of influence attempts. Chief among them was his attempt to rope in Vigyan in to a collaboration with RAC. Later he influenced the Standardisation process. He participated in the conference of 1976 and immediately aligned himself with Mr. KS of RAC. Both Mr. KS and Mr. RT worked together right from 1976 as an alliance of champions in promoting the hand pump. Was the alliance necessary? It seems that an alliance between RAC and UNF was essential if the innovation had to succeed. UNF had links to the various provincial PHEDs,who would eventually become the market for the innovation. UNF was also providing finances for

the installation of hand pumps. It would have been rather difficult for RAC, a heavy engineering co., to persuade PHEDs to accept RAC's design. On the other hand, it would not have been possible for UNF to introduce into their market a handpump without the support of a group like RAC. Each of the alliance partner had his own strengths and command over his own resources. They pooled these together to meet a common goal, development and diffusion of a good deep well hand pump.

4.4.1.3 The way the alliance worked: Champions in general use transformational leadership behaviour. They exhibit high risk taking and innovative behaviour. They initiate more influence attempts. One of the major roles this alliance performed is the role of 'gate keepers'. The alliance acquired and disseminated external technical knowledge to the innovators. Mr. RT and UNF had a continuous link with the Vigyan group and other PHEDs. Any new development was passed onto the innovator group at RAC. They enabled meeting between Vigyan and RAC groups. They sought suggestions on RAC's work.

Another role played by the alliance was to procure support and resources for the innovation at the time of development and trial. Mr. KS procured the financial resources from the head quarters. He also liaisoned with the CPHED and mech. R&D in getting the designs of RAC evaluated. Mr. RT arranged to finance for various province PHEDs to procure handpump for field test purposes from RAC. He also arranged for the close monitoring of PHED's field evaluations.

Another important task carried out by this alliance was to initiate steps to create a market for this innovation. Since the sole purchaser of this device would be different provincial PHE departments, it was important to win them over to the new product. This was done in two different ways. Mr. RT of UNF arranged for funds for PHEDs of various states to procure pumps from RAC for trials and tests. Mr. RT and Mr. KS used their links with CPHED. All provincial PHEDs have active links with CPHED. These channels were used to promote the pump. The second path adopted was to gain legitimacy for the pump, by getting an independent organisation like the NSO, to accept the design as a superior one. This third party certification provides the innovation with a superior status enabling it to claim a legitimate share of the market.

It is not sufficient if the market is made ready to accept the innovation. The production, distribution, installation, maintenance and training of users in operation need to be organised. This necessitated creation of a network of manufacturers, quality certifiers, trainers, financiers and implementing agencies (PHEDs). The alliance of champions ensured creation of such a network. In fact this has been cited by Prof. RP of Vigyan as the singular cause for success of RAC's deep well hand pumps. He says that the identification of few selected manufacturers and introducing of strict quality control measures at the manufacturing stage by appointing a foreign quality control firm as an agency to help in this task is definitely a

major improvement.

Was an alliance between Mr. KS of RAC and Mr. RT of UNF necessary? Would it not have been possible for one of them to accomplish all these tasks? If we carefully look at the development and dissemination of this innovation, certain task had to be performed by a champion. These include:

(a) activities to acquire, translate and distribute to the designers, external technical knowledge and development in other groups (gate keeping role),

(b) to support the design and development by providing access to resources of the organisation and to project it from interferences as innovation ensures (project champion role),

(c) to reduce the barriers to disseminate by market development, by obtaining a legitimacy through certification process (market development role), and

(d) to create a network to manufacture, install and train the user in the operation of the innovation (a networking role).

It is our view that these roles can not be done by one champion as they require different skills and different resource bases. For instance, Mr. KS, positioned as GM, RAC would not have been able to on his own develop markets (provincial PHEDs) without Mr. RT of UNF. Similarly Mr. RT (UNF) on his own could

not have performed the tasks of either certification by NSO or developing manufactures. Hence an alliance of champions was necessary.

### 4.4.2. Strategy for Dissemination of Innovation

4.4.2.1. <u>Strategy adopted by the Vigyan group</u>: As we had seen earlier, the Vigyan group perceived itself as a consultant trying to solve the problem of the client PHE department. We must also note that the client PHED did not seek out the consultant. The relationship was arranged by the executive committee of the CST. The solution in itself was very simple - a few modifications in the existing specification. The strategy for dissemination of this solution was evolved by Prof. RP and the secretariat of CST. The elements were field trials, education/training of client's (PHED) field staff, modification in the technical specifications of future purchases and evolution of a standard. These elements were evolved not as parts of a preconceived grand strategy, but over time in response to client's behaviour. Initially the Vigyan group thought it to be sufficient to provide a 'do-it-yourself' manual specifying the changes to be undertaken in the field. When it found that this did not work, as the manual itself did not reach many field staff, the group proposed training. Though the Vigyan group mooted the idea of standardisation in the first place, its action in the process was reactive. The strategy was marked by reactive solutions, incremental small steps and disjointed elements of action. The strategy was made in the

'adaptive mode' (after Mintzberg).

If we look at the relationship between PHED and the Vigyan group, we find it to be lukewarm. The PHED, though coo??rated with Vigyan, was not very enthusiastic about this solution process. There were delays in providing necessary information to the group. PHED is a bureaucratic department. In such departments, the decision making, to use the Allison framework, would either be an organisational process of incrementalism or as a bureaucratic political process. The nature of the process used would depend largely on people, time and the problem itself. If we take a closer look at the 'PHED' initiatives and reaction, we find two relationships being maintained simultaneously. They cooperated with Vigyan and adopted somewhat slowly, the solutions. On the other hand, their organisational process and procedures involved a close association with CPHED and the UNF. Their own engineers were deputed to UNF and CPHED gave them the technical inputs for framing their plans. In the normal course of their work, these outside organisations (CPHED, UNF) provides alternative solutions to the problems faced by PHEDs. When the decision making is disjointed incrementalism where the search for solutions are in the neighborhood, then an adaptive strategy as adopted by Vigyan must have worked. It did work till a NSO standard on Mark II pumps were issued. The standard operating procedure of PHED, placed a greater reliance on CPHED/ UNF than their own consultant. A lack of understanding of the relationship between CPHED/UNF and PHEDS by the Vigyan group resulted in the failure.

4.4.2.2. <u>Strategy making at RAC</u>: There are certain striking elements in the strategy followed by the RAC group. Their moves were proactive, in contrast to the reactive stance of Vigyan group. There was an active search for new opportunities to promote their innovation. Starting from the announcement of their intention made at the 1976 conference, the RAC and in particular their general manager were keen to enlist the support of as many organisations as possible. They linked with UNF and CPHED and through them a number of other organisations. They kept the dissemination of their innovation as the dominant goal and enticed a number of manufacturers, and provincial PHEDs to participate in their attempt. They were prepared to organise resources for these organisations to participate in the network. For instance they designed jigs and fixtures so that the manufacturers can start production easily. They were willing to learn from their contacts and from field trials and make modifications in design. In short, their strategy was made in an entrepreneurial environment and had the characteristics of an entrepreneurial strategy.

It is interesting to note that an entrepreneurial strategy has succeeded in organisations (provincial PHEDs) where the decision making tends to be a mixture of organisational process model and the bureaucratic model. The adaptive strategy of the Vigyan group did not succeed. RAC was able to influence the decision making of provincial PHEDs, by initiating influence attempts through the UNF and CPHED. We must note that the regular

organisational process of provincial PHEDS involve a close interaction with UNF and CPHED. It is this better understanding of the organisational process and using the links already existing made the RAC strategy work. Realisation that standards and approval by a national standard organisation are crucial to the promotion, made RAC to influence NSO to adopt their design. Here also the links among RAC, UNF and CPHED was exploited to influence NSO.

### 4.4.3. Changes in the Innovation Characteristics

4.4.3.1. Development at Vigyan: The development at Vigyan was initially focused to enhance the reliability and to reduce frequent breakdowns of existing pumps. A detailed failure analysis led to modification to the existing designs by retrofitting some additional components such as spring washers, lock nuts and better bucket valve. The objective was not to disturb much the existing arrangements of manufacture, installation and service. Any suggestions that would lead to a shake up of existing system was not accepted. Initial attempt by the original convener Dr. GR in designing a new pump was given up by Prof. RP. Similarly suggestions emanating from engineers of PHED for introduction of major changes such as PVC pipes or neoprene bucket valves were not approved. The response by Prof. RP to the RAC new head design was lukewarm for the same reason. An implicit norm of least disturbance to the existing system seems to have been used to evaluate suggestions for changes and suggestions which needed an evaluation of hip norm itself was not

accepted. Organisations tend to create systems that inhibit learning that calls into question their norms and basic policies (Argyris and Schon 1978). Since the focus of the work at Vigyan was so narrowly limited by the innovating group itself, they failed to learn from their relationship with others.

The focus was enlarged a bit when the group initiated attempts at standardisation. Even in this activity their attempt was to standardise the components in such a way that existing system could handle. When the NSO came up with a draft standard, that was viewed with these objectives and a number of changes proposed to it.

The reasons for such narrow focus are not difficult to see. The group defined its role essentially as a consultant solving a specific problem and making the client accept the solution. The problem of failing handpumps were traced to components whose performance were improved by modifications. The system of manufacture, quality control, certification, installation and maintenance was not the scope of the study. Handpumps as a product was existing for many centuries and the modifications suggested were not really novel or complex. The Vigyan group did not look at handpump as a new technology needing to be disseminated. An attitude of problem solving for a specific client coupled with an assured state sponsorship led to the rigid focus. This led to rejection of all suggested changes and eventually the failure of the innovation.

4.4.3.2. Development at RAC: Right from the beginning RAC viewed

their work as a totally new product development. Since the company's main business was in heavy engineering, they had no preconceived notion of what the pump should look like. Characteristics of their innovation were arrived at based on the interaction they had with mech R&D, UNF, provincial PHEDs and the Vigyan group. They developed their innovation based on trial and error and benefited from inputs received from field trials. They were open to suggestions from any quarter. Unlike the Vigyan group, they had not fixed any norm other than likely impact on performance to evaluate the suggestions. They knew that once the development was over, they have to pass on the design to small manufacturers as the hand pump was an item reserved for small scale industry. This development was not crucial to the finances of RAC, but earned lot of goodwill. The RAC group thus was willing to try every suggestion and incorporated suitable ones in their design.

Initially the development concentrated on the above- ground components like the head, operating lever etc. This new head was tested in field in a province and found to increase the reliability. Later the RAC group absorbed some development from Vigyan regarding the below the ground components. The draft standard carried out by the NSO initially, had the specifications incorporating the works of both Vigyan and RAC group. Continuous field trials by RAC, led to revision in standards, dropping some of the modifications proposed by the Vigyan group.

We can speculate on the reasons for the attitude of

accepting changes that existed at RAC. RAC was a business enterprise, dealing with markets and external environment more frequently than Vigyan. RAC had adopted an entrepreneurial strategy for dissemination. These created an environment conducive to look at proposed changes with more openness.

In the case of 'Vigyan' an adaptive dissemination strategy coupled to a state sponsorship resulted in refusal to changes. In the case of RAC, an entrepreneurial strategy coupled to sponsorship led to changes. It is important to understand the nature of sponsorship. In the case of Vigyan both the motivation for the development and the resources for the dissemination came from the state sponsorship. A dependency relationship - that is Vigyan depended on the state sponsorship for every action, got developed. It was sufficient for Vigyan to 'satisfy' the sponsor. Hence they had a close mind regarding changes.

On the other hand, RAC did not derive either the motivation nor the money from its sponsor UNF or CPHED. The links were established by RAC and these links were used in the dissemination strategy. The sponsorship of UNF/CPHED was used to gain access to the market (provincial PHEDS) and to influence the standardisation process. Sponsor was also the client for??the Vigyan group. UNF/CPHED were not clients nor market for RAC. This vital difference in the nature of sponsorship along with the dissemination strategy led to difference in behaviour with respect to focus of innovation among Vigyan and RAC.

**4.4.4. Network**

4.4.4.1. Initiation of the network: Dissemination of Mark II hand pump of RAC required a number of specialised tasks to be performed in a well coordinated manner. All tasks could not be handled by RAC itself. Manufacture of hand pumps was reserved for small scale sector. Installation and commissioning was done by provincial PHEDS. Finances for the programme came from UNF, central government and provincial governments under a number of schemes. Maintenance of the pumps were regarded as a multi tier scheme by provincial PHEDS which involved honorary care taker at the village level. These caretakers need to be trained in minimum preventive maintenance. These multiple tasks were achieved by creating a loosely coupled network of a number of organisations. UNF and RAC (the alliance of champions) took the initiative for establishing such an informal network. The network was necessary as no single organisation could perform all tasks mentioned above. For a traded product, the market place provides these linkages to form the network based on market exchange. However for a product to be disseminated in a governmental welfare programme, the functions normally performed by the market needs to be mimicked. Informal networks are such a mechanism.

In this case RAC took the initiative to develop links with identified manufacturers in the small scale sector. It provides them with jigs and fixtures required for manufacture and training of the industry's personnel. UNF took the lead in establishing quality control and certificate procedures. UNF using its existing links with provincial PHEDs, established a training

strategy for training of caretakers in the offices of provincial PHEDs.

4.4.4.2. <u>Structure of the network</u>: The network was an informal one, not mandated by law or rules of the government. The participation in the network was based on agreements arrived at by consensus. The network had a powerful centre, in UNF which was linked directly to every member. The membership consisted of several manufacturers, quality control agencies, provincial PHEDs, cphed, RAC and non-governmental training organisations like polytechnics etc.

RAC had strong links with UNF and manufacturers, but had weak links with provincial PHEDs and trainers. The network could be represented as shown in figure 4.2.

Apart from UNF, no other member had strong links with every other member. This structure automatically gave UNF the leadership of the network. The network enabled flow of funds, technology, trained manpower and information on the progress and problem of dissemination to targeted members capable of handling manufacture, quality assessment, installation, maintenance and education. Since different members had responsibilities for different functions, coordinating flow of resources mentioned above became the natural responsibilities of leader.

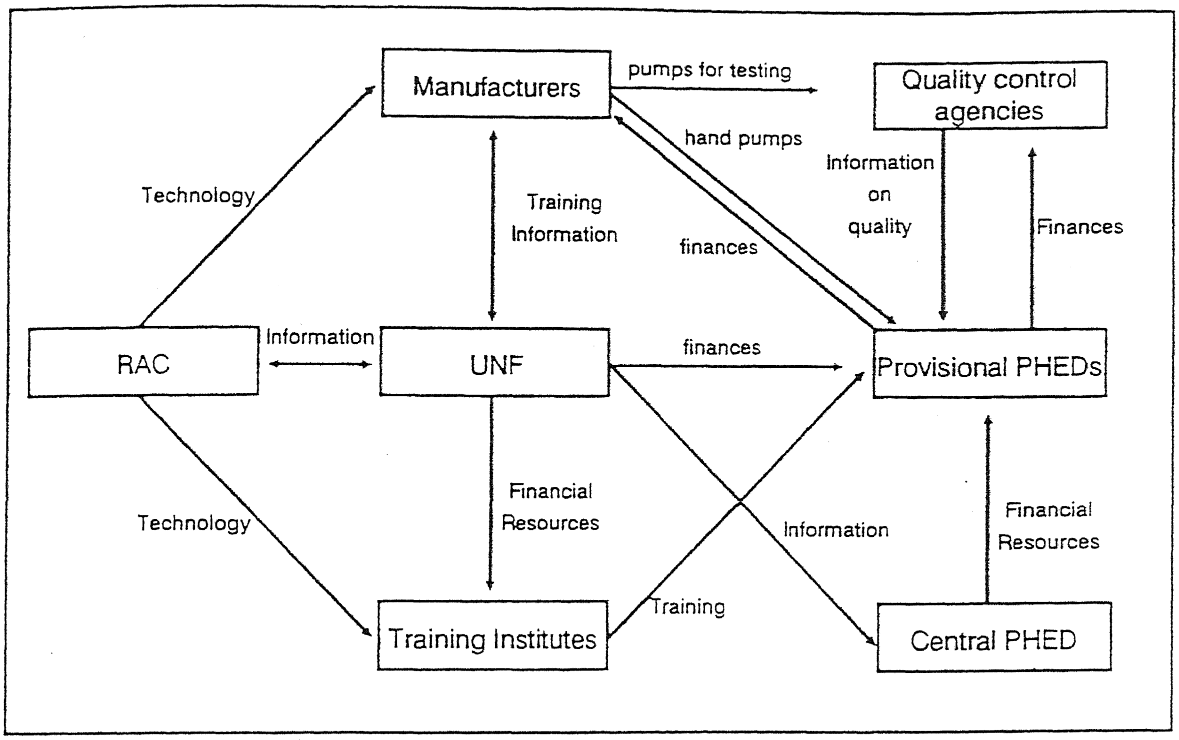


Figure 4.2: Network for diffussion of deep well hand pump

4.4.4.3. Functioning of the network: Perception of dependence on others for resources or for performance of specialised tasks spurs the development of inter organisational relationships. Multiple relationship with a common objective and a common member organisation leads to networking. The stability and the endurance of the network depends on domain similarity, (common services or clients or skills), resource dependency and the nature and frequency of communication among the members. The functioning of the network would then depend on (a) production of resources, (b) control of interaction and information flow and (c) resolution of conflicts.

In the handpump network the production of financial resources was ensured by the UNF, CPHED and the provincial PHEDs. The finances came largely from UNF funds. Both CPHED and the provincial PHEDs also contributed to the finances. The technology as a resource was ensured by RAC and the standards evolved by NSO.

The basis of interaction among members was the exchange. Both the principles of economic exchange and the social exchange operated. Manufacturers, quality control agencies participated for the monetary returns ensured by the economic exchange. On the other hand polytechnics, non-governmental organisations and RAC participated for the status and esteem that would result for their organisations. The characteristic of the relationship among members were largely bureaucratic, in the sense of specialisation of tasks and governance by preset rules and procedures. The

coordination of members action, an essential function, was performed by UNF, but there was no hierarchy to enforce such coordination. The coordination was effected through the adherence to mutual agreements and acceptance of UNF as the leader by the members. There were no formal, authorised channels of communication. The entire operation of the network was carried on by the informal agreements, and the norms ordained by the exchange process. The case does not throw much light on conflict resolution methods. But given the pre-eminent position of UNF, we can expect UNF acting as an arbiter of conflicts.

4.4.4.4. <u>The reason for the network</u>: It is important to probe why a loose informal network with UNF as centre was instituted instead of a formal coalition of organisations. A formal coalition would need (a) pooling of resources for a common cause and (b) instituting a common command structure. Both these are difficult as the number increases and nature/structure of organisation varies. The motivation of organisations in performing specialised tasks also vary, making it difficult to form a coalition. Coalition would mean some loss of independence for the partners, whereas it is easy to withdraw from a network. Hence if performance of specialised tasks leading to achievement of a common goal can be ensured of a network rather than a coalition member organisations prefer a network.

**4.4.5. Role of Small Groups**

<u>4.4.5.1. Development at Vigyan:</u> The development of improvement to handpumps at Vigyan was initiated by the executive committee

of CST, a small group of 10 members. It desired that the development be guided and reviewed by a small working group comprising innovating scientists and then user PHED representatives. Prof. GR and later RP were the conveners of the group. It is fairly evident from this case that the working group failed to guide and oversee the development of the improvements. The meetings themselves were very few, and participants changing quite often. A cause for failure for the group may be traced to the role of the leader. A successful leader of a group performs both social functions (related to maintenance of status, esteem etc.) and task related functions. The leader must be both a social leader and a task leader. The conveners of the working group (GR or RP) were essentially task oriented leaders and failed to provide the social leadership to the group. There were no informal get together or visits. All interactions were purely task oriented.

The executive committee of CST which has the objective of reviewing and guiding the project to ensure its successful dissemination also failed in its task. In the handpump case, the executive committee of the CST relied on authority of its member (Chief Secretary, Development Commissioner) to effect dissemination. Dissemination cannot be mandated by formal authority alone. Flow of resources, technology and??kills must be ensured which could not be done by CST.

4.4.5.2. The standardisation process at NSO: Another important small group was the standardisation committee set up by NSO. The

membership included representatives of some manufacturers, provincial PHEDs, CPHED, RAC and UNF. The group was eager to adopt a standard which would have acceptance of Vigyan group also. The group wanted to adopt a standard that would have least resistance. The group arrived at a standard in 2 meetings itself represents the success of UNF leadership as compared to the leadership of the executive committee of CST.

4.4.5.3 Importance of small review or standardisation committee: A review or standardisation committee provides legitimacy to the action of the members of the network carrying out a dissemination programme. Such legitimacy is important in government programmes as they are open to review by legislature, press and judiciary. Review committees or standardisation committees are also used to syntheses development at a number of innovating groups and to gain their support for the programme. Review committees on standards fix norms in such a way to include the development of most of the innovating groups. In this case the NSO committee though drawn for the UNF network tried to accommodate the recommendations of Vigyan. Review committees in that sense act as an agent for lowering the barriers to innovation.

## 4.5. WOOD GASIFIER

### 4.5.1. Introduction

Woodgas generators have been used to drive buses during the last world war. They used wood, charcoal or coal and produced gases to run an internal combustion engine of 10 to 200 horse power capacity. After the war, they fell into disuse.

In 1974, a group of faculty at a national scientific institution, Vigyan, established a division for the Development of Rural Technologies (DRT). One of the areas identified by this group was to develop technologies that would reduce dependence on fossil fuels in rural areas. They wanted to develop small wood gasifiers (a) to replace diesel in diesel engine pumpsets, and (b) to generate electricity to meet the lighting load of small remote communities. However design data on small gasifiers of less than 10 horse power were not available. Some work on design of such a gasifier was initiated by Dr. US at DRT. By 1980 a prototype was built.

### 4.5.2. Development of Woodgasifier

To measure the performance parameters of the prototype and optimise the design, a proposal was submitted to the Council for Science & Technology (CST) of the PS province by Prof. SM and Dr. US of Vigyan. They proposed a project of Rs.35,000 and a time duration of 15 months to develop and test small woodgas generators.

The Executive Committee of the CST considered this proposal in August 1981. One of the committee members pointed out that overall efficiency of these systems was likely to be quite low and hence they might not be economical. The Secretary, CST, explained the advantages of providing the motive power for pumpsets and electrifying small communities using locally available wood. Considering the fact that wood can be grown in a renewable way and hence would lead to reduction on dependence on fossil fuels, the committee approved the proposal.

By March 1982, a gasifier that produced a clean burnable gas was developed. Performance of the gas scrubber and cooler was satisfactory. The project working group felt that they needed more engineers to make detailed engineering studies and they would also require more equipment. This request was approved and the budget doubled.

By March 1983, when the project concluded, it was able to produce 1 horsepower output through use of gasifier gas in a 2 horsepower petrol/kerosene engine. No petrol or kerosene was necessary to run the engine. But this was very sensitive to size of wood chips. The gasifier was also run with a diesel engine. It produced a satisfactory output. It replaced 80% to 90% of the diesel fuel requirement.

The group then submitted a proposal to start phase-II of this project to carry out detailed engineering, to fabricate the gasifier, to undertake long duration testing, and demonstrate in field conditions, the viability. Investigation into the

possibility of briquetting loose biomass such as saw dust, rice husk to be used in this gasifier, was also to be undertaken.

The Executive Committee of the CST approved this proposal with a duration of 3 years and a budget of Rs.5,25,000. The Executive Committee meanwhile wanted the secretariat of the CST to undertake a study about the problems of availability of wood in case these gasifiers become popular.

**4.5.3. Research in Other Institutions**

In a separate development, the federal government and a foreign Agency for International Development (AID) agreed in June 1982 to collaborate on an alternative energy programme. This programme had a sub-project on low power biomass gasifiers. Two groups, including one of Prof. DG of a national institute (NIT-1) were given projects to develop a technology to convert biomass into char and to develop a gasifier to use the char. The foreign costs were met by AID while the domestic costs were met by the department of the federal government (DFG). Dr. SR, Director of a provincial energy promotion agency, was made the Chairman of the DFG Committee on gasifier programme. Apart from such government funded venture, a private firm had also undertaken development of a gasifier.

**4.5.4. A Workshop**

In February 1985 there was a workshop organised jointly by the DFG and the AID to review the progress made in the gasifier

programme. Vigyan and other seven groups presented their work at the workshop. It was made known at this workshop that the DFG was setting up its facility for evaluating various designs of gasifiers at a national institute of Technology (NIT-2). It would also organise a training programme for operators. The DFG had also reconstituted the national committee on gasification with Prof. PP of NIT-2, as Chairperson. Prof. SM of Vigyan was made a member of this committee.

Amongst the gasifiers presented at this workshop, two from agricultural institutes and one from NIT-1 were yet to be tested, while the others were in preliminary stages of design. In this meeting it was clear that the only gasifier on which there was some long duration testing was the one available from the Vigyan.

Seeing that the gasifier's performance was very good, and there is likely to be a large potential, Prof. SM requested permission to obtain a patent which was duly accorded by CST. However he took no further step in patenting the design. He initiated a process of technology transfer to manufacturers.

**4.5.5. Review of Project by CST**

In the meantime doubts about the environmental safety of these gasifiers were expressed in the letters to a local English newspaper. A reply was sent by the CST stating that the technology will be released for field use only after a careful review of the performance, safety precautions and environmental

concerns. Accordingly the CST appointed in January 1986 a review committee with the following terms of reference.

1. Whether the project has achieved the objective stated in the proposal,
2. Whether the design is ready for diffusion,
3. If not, what steps should be taken to make it ready for diffusion, commercialisation, and
4. What should be the further course of action.

The Committee was chaired by Prof. SD, a member of the CST Executive Committee. The other members were GR, (another member of Executive Committee), Vice-Chairman of Executive Committee, Prof. PP of NIT-2, Dr. PV of DFG and Dr. JN, Managing Director, provincial agro industries corporation. The Secretary, CST acted as the Convenor of this review committee. The provincial Agro Industries Corporation had expressed an interest in absorbing this technology and hence its Managing Director was nominated to the review committee. The review committee met on 4 January 1986. The review committee found the project had achieved its stated objectives but required improvement in the accessories like blower and wood chipper.

The Committee deliberated the use of gasifiers in both diesel and petrol engines. If the wood gas could be used in petrol engine, it could eliminate the use of petrol completely, but in a diesel engine it could replace diesel only to the tune of 80% of normal consumption. Prof. PP emphasised the need for long term trials on diesel engines. Diesel engines are more

prevalent than kerosene or petrol engines and also the efficiency of the system in a diesel engine would be more than in petrol engines. Hence, promoting applications of the gasifier along with the diesel engine would be more viable. GR wanted the investigators to test the performance of the gasifier on other fuels like corn cobs, cotton stalks etc. Secretary, CST contended that if one could increase the compression ratio in a petrol engine, then the gas from the gasifier coupled with a petrol engine may be equally viable. Vice-Chairman, CST said that gasifier should be able to cope up with any kind of engine. The Committee recommended that production engineering of the gasifier system should be started. Prof. PP suggested that 20-25 systems should be made by the project group itself to understand the problems of production engineering. Vice-Chairman, CST wanted a detailed market survey to be undertaken by CST secretariat and Dr. JN suggested a thorough safety analysis to be done. The committee suggested that the project group should perform extended trial with 1500 rpm diesel engine and also with a petrol engine with a high compression ratio, if available. The Committee recommended that the economics of an illumination system using gasifier diesel engine generator set be assessed by the CST secretariat. The review committee recommended to the Executive Committee to start the next phase of the project with the above objectives.

**4.5.6. The Testing Phase**

Two proposals were considered by the Executive Committee. (1) Demonstration of 10 gasifiers to be undertaken in various

conditions and (2) Feasibility of briquetting loose biomass such as husk. It was felt that 2 acres of fuelwood plantation could irrigate 10 acres of paddy. The proposal envisaged that 10 villages would be chosen and a gasifier system would be installed at these villages. The operators would be trained and the system would be maintained for 2 years. The proposal suggested that District Rural Development Societies (a government undertaking) was to be involved in selection of villages, construction of the shed, selection of the operators and fuelwood plantation. The DRDS will also have to bear the cost of fuelwood plantation, hardware, salaries of operators and fuel for the system. The CST will provide two engineers to the project. This proposal was discussed at the Executive Committee meeting held in March 1986. It was informed to the committee that owing to the financial resource crisis at the CST, CST has to depend on DRDS to provide a major part of the finances and because of the similar constraints that would be faced by the DRDS, the number of gasifiers has been reduced to 10 from the originally recommended 20. The Executive Committee debated in detail the likely impact on wood resources, problem of retrofitting and also the feasibility of briquetting. The Committee also suggested that DFG may be approached for funding. The Committee approved the demonstration programme and also other proposal on briquetting loose biomass for use in gasifiers.

### 4.5.7. Sponsoring Dissemination

By May 1986, four gasifiers were made by one local manufacturer (MMF) and they were tested. However, it was clear by

July 1986 that no funds would be available from DRDS. In the meantime a brochure on the gasifier, its use and the economic advantages was prepared. The DFG was approached and it informed that they may fund only the gasifier part of the system and not expenses like shed construction, training of operators and the diesel engines. Since four gasifiers were already built assuming that funds would be available, the project team started looking for clients. In August 1986 the Andaman Nicobar administration requested for estimates of expenditure involved in supplying gasifier based power generator system for illumination. Similarly the Orissa Government wanted two gasifiers for a demonstration programme.  A number of manufacturers also showed interest in absorbing the technology. The Forest Department of the Government of PS State was willing to pay for 5-10 systems and wanted to know about identifying the sites for installation.

Dr. PV, Director of the Biomass Programme at DFG who had attended the review meeting wanted Vigyan to make 50 sets of gasifier and field test them. He was willing to fund this programme. In February 1986, Prof. SM informed Dr. PV of the specifications and costs of gasifiers, engine pumpsets, generator sets etc. He had also indicated that trials could be done both on diesel engines as well as petrol engines. In April 1986, DFG accepted the proposal. 50 gasifiers would be made by Vigyan and given to users who could bear the cost of engine, pump set or generator set. Operators would be trained by Vigyan. Users will be identified by both Vigyan and DFG. The cost of the project was

fixed at Rs.9,20,000 with a duration of 3 years. Gasifiers were supplied through CST to Orissa, Andaman & Nicobar and directly by Vigyan to a few users.

**4.5.8. Federal Initiative**

Mr. KS, an officer with the DFG was transferred to its biomass division during June 1986 and was assigned gasification programme. He suggested that Vigyan should look for a manufacturer to whom the technology could be formally transferred.

By September 1986 a number of groups claimed to have developed gasifier technology. The DFG was keen to see atleast a few designs manufactured and used in large numbers. As in the case of other technologies such as wood stoves and biogas digesters, the DFG had made adequate financial provision for a field dissemination programme of gasifiers too. KS was under pressure to launch a field programme for which funds had been budgeted.

Some of the research groups had shown their gasifiers to the Secretary, DFG. They gave an impression that technology was ready and DFG must now disseminate. However, in reality only a few prototypes had been tested for reasonable time in the field. Certain steps were therefore planned to overcome the effects of possible large scale failure. The manufacturer was to give a one year performance guarantee. Besides, the entire package was to be given free, so that in the event of failure, the user did not loose anything.

### 4.5.9. The Package

The next issue to be decided was the detail of the package. Prof. PP recommended that the gasifier be fitted to a diesel engine rather than a petrol engine. Though a diesel engine would still require 20-25% diesel to run it, the petrol engine if run purely on gas would deliver, a much lower power. Its exhaust would have a lot of unburnt carbon. A diesel engine can also be run purely on gas, with replacement of fuel injection system by a sparking system. In that case, if the gasifier fails, however, the user cannot revert to the original fuel. In addition, diesel engines are more rugged and farmers and other users are familiar with it.

If gasifiers were to be used along with diesel engines, why not retrofit them to existing engines of farmers? This issue was also discussed. Woodgas contains some amount of tar and dust, which affects the life and maintenance needs of engine. Prof. PP was yet unclear about this. There was no data from sufficiently long operation to provide an answer. Therefore in the event of failure of a retrofitting engine, it would not be possible to decide whether this was due to gas or due to the prior history of the engine. The users would anyway make a claim for replacement. It was then decided that the package should also contain a new engine and pumpset or a new engine and alternator.

Based on this, KS circulated a draft note on demonstrative application of gasifier to all research groups in September 1986.

He proposed that groups who have the final product should transfer the design to a manufacturer of their choice. The manufacturer must bid in an open tender for supply of 100 systems (all inclusive package) each to DFG to be located in field through provincial agencies. One year warranty and bank guarantee must be provided. He suggested that research institutions like Vigyan will be provided funds for inspection, testing and training of operators.

By December 1986, Prof. SM of Vigyan informed DFG that he has found one manufacturer who can supply 100 systems as per DFG conditions. KS indicated to Prof. SM that he was in a hurry and would like to finalise the offer soon. He invited the manufacturer MMF to DFG for discussions.

**4.5.10. Dissemination Structure**

The federal government then advertised in the press inviting tenders for supply of these systems to locations chosen by the DFG. They were to manufacture through technology transfer agreement with the approved developers of the design. The DFG would accept any gasifier that replaced 60% of the diesel in a diesel engine and which was certified by the test unit set up at NIT-2. The gasifier dissemination programme was formally was launched by DFG in April 1987. Under this programme, a gasifier, its cleaning and cooling accessories, a diesel engine and a pumpset were to be given as a package free of cost. The user had to only take care of erection of the shed and other civil works.

The cost towards packaging and transportation were also met by the federal government.

This programme was implemented through nodal agencies for renewable energy devices set up by various provincial governments. In the initial year only 2 nodal agencies were chosen; the CST itself in PS province and the other in a western state. Initially two manufacturers, MMF with Vigyan design and Energy Co. with its own design were chosen. Orders were placed with MMF to supply 100 units of the system based on the design developed at Vigyan. 50 of these systems were to be installed in PS State, 25 in a western state and other 25 at various other locations to be later chosen by DFG. The earlier project of 50 gasifier was modified to a scheme providing testing and inspection services to M/s MMF and training the users.

**4.5.11. Technology Transfer**

The MMF was issued a letter by the Vigyan, stating that their application for technology transfer would be considered and if the agreement could be reached, the technology transfer would be effected. However the process of arriving at a formal agreement took more than 2 years. But the Vigyan transferred the technology to MMF during this two year period pending finalisation of agreement. The CST had earlier decided that commercialisation of this technology be done by the Consultancy Centre of the Vigyan. It however did not demand any payment towards the CST. Eight firms approached the CST for transfer of

technology and by a process of negotiations and assessment, the Vigyan chose M/s MMF and M/s.HS. However, M/s HS did not want transfer of 5 HP gasifier technology and wanted a technology at higher rating which was under development. Hence the technology was transferred to MMF. Even before this process could be concluded, Prof. SM had assured MMF that the technology would be preferably transferred to them because they had fabricated various prototypes over the years.

#### 4.5.12. Distribution

The CST, through a public advertisement identified beneficiaries and installed the gasifiers. The Vigyan took the responsibility for testing the gasifiers made by MMF, train the personnel and solve any unusual technical problem. During the year 1987-88, the CST installed 50 gasifiers in various sites in the province. It also installed gasifiers in some other provinces. For the purposes of informing various clients, a note was prepared by the CST. This note compared the wood gasifier pumping system against 100% diesel pumpsets. This analysis showed that with 200 hrs/year operation the wood gasifier was marginally cheaper if wood was available at no cost. However if the system could be operated for more than 600 hours/yr, this would be cheaper even if one paid Rs.300 per ton for wood.

#### 4.5.13. Failure and Correction

A number of installations showed failure of the nozzles in the wood gasifier after about 400 hours of operation. The ash

handling system also needed improvement. The wood chopper failed at almost all locations. Hence the design of the system was modified by the project group. Some materials used were changed and the gasifier was kept on a water seal. The improvements were passed onto MMF. In the meantime the DFG approved the designs manufactured by another firm By 1989, 4 manufacturers with different designs were approved by the DFG. The subsidy of the gasifiers for water pumping was reduced from 100% to 80%. But none of these manufacturers was yet able to sell any system without subsidy.

## 4.6. WOODGASIFIER - ANALYSIS

### 4.6.1. Stages in the Innovation Process

The development and dissemination of this innovation spanned more than six years. The innovators identified gasifier of small capacity as an innovation worth attempting, collected necessary information from earlier research, and even developed a prototype before applying to CST for a grant in 1981. Three of the eight functions, identified by Pelz in the course of innovations had been carried out prior to this date. They are concern, search for information and appraisal of existing alternatives. From a little before 1981 and upto 1985, activities that fall under 'design' function of the innovation were carried out. The tasks of seeking commitment, trial implementation, incorporation and diffusion were all carried out more or less together between 1985 and 1987. The process of seeking commitment from a number of agencies, started at the workshop in 1985 and continued till the DFG invited manufacturers to supply gasifier, in March 1987. After the CST review meeting of January 1986, tasks were concerned with trial implementation of a limited number of gasifiers under the project sanctioned by DFG. The activities related to incorporating the innovation in regular programmes of the government took only about six months from September 1986 to March 1987. The quickness of the process from January 1986 to March 1987 compared to a long development period of five years needs to be noted.

### 4.6.2. Champions

In the literature on innovation processes, role of champions has been highlighted time and again. In the case of gasifier, three individuals namely Prof. SM at Vigyan, Dr. PV and Mr.KS of DFG had played significant roles in the cause of this innovation. If we use the characteristics of champion as mentioned in Chapter II, Prof. SM and Mr.KS emerge as champions.

Prof. SM entered the innovation process when Dr. US had already built a prototype and there was need for extensive testing. Prof. SM was not the innovator. He chose to pilot the next phase when organising and sponsorship was important. Prof. SM used the forum of AID workshop to establish links with other gasifier researchers and DFG. He influenced Dr. PV of DFG, after the 1986 CST review meeting to sanction a field trial project at a number larger than what had been recommended by the CST review committee. He negotiated and started the process of technology transfer to MMF even prior to formal agreement between Vigyan and MMF. The formal agreement process took nearly 2 years, before which Prof. SM issued a letter to MMF even earlier, which enabled MMF to procure order from DFG. He quickly agreed to the modifications in the technology package as suggested by Prof. PP of NIT (2), so that the dissemination programme could get on without delay. We must keep it in mind that though the Vigyan gasifier had been tested for a duration longer than other designs, still was not enough to promise a trouble free operation of a few thousand hours in the field. In the event of failure,

both Prof. SM and Vigyan stood to lose some reputation. Thus Prof. SM clearly took risks. While he was engaged in a dialogue with DFG, Prof. SM maintained his links with CST and the departments of PS provincial government. He agreed to provide gasifiers to the forest department and DRDS. He also agreed to transfer the technology to an agro industries corporation of PS province. Thus he also forged a link between CST and DFG. He actively linked various organisations that may be useful for the success of innovation by bringing them together and maintaining information flow.

Mr. KS who took over at DFG from Dr. PV could have allowed the process to continue at its normal pace. He could have waited for field trial phase, which started in June 1986 to be over before taking a decision on the dissemination programme. But he played a role of an active champion. He initiated steps which resulted in the speedy dissemination programme. He exhibited high risk taking abilities by putting together a package to push, a yet untested innovation. Though he covered the risks by suitably amending the package, he put his department's reputation (and his own) at stake, by short circuiting the field trial phase. By bringing in manufacturers into the programme, he created a network which could sustain the programme. He fashioned out an innovative dissemination programme. It is customary for the federal government to approve designs as well as manufacturers. However the choice of designs and the particular manufacturer is normally left to the field implementation agency, who are

provided with funds. In this case Mr. KS however placed orders with manufacturers and presented a fait accompli to field agencies. He established himself as an active champion of gasifier.

### 4.6.3. Alliance of Champions

It would be interesting to see if these two champions struck an alliance and mutually reinforced each other. The first contact between the champions was made, at the initiative of Mr. KS in June 1986. He suggested to Prof. SM at Vigyan to look out for a manufacturer to whom the technology could be transferred. After this handshake, things moved in rapid pace. There were certain strategic moves by this alliance in the next nine months to get the innovation disseminated. Till June 1986, the only groups that were interested in the gasifier were the designers and the members of the gasification advisory committee. The dissemination programme needed manufacturers and field implementation agencies. The normal practice adopted by DFG in other programmes were to approve designs, then approve manufacturers and release funds to the identified field agencies. The field agencies were given the freedom to choose the design as well as the manufacturer. This alliance of KS and SM, changed this pattern. It brought the manufacturers into the programme formulation stage itself. KS circulated the draft programme not only to the members of the gasification committee but also to the field implementing agencies, designers and likely manufacturers. Prof. SM helped in this by identifying a manufacturer and also getting the CST of PS

province to participate as a field implementing agency. Creation of a wider network which has stakes in the innovation dissemination seems to be an essential element in the strategy adopted by the alliance.

Another important aspect of the working of the alliance seems to be activities leading to lowering the barriers to the innovation dissemination. This was done in two ways. One was to redesign the innovation package to take care of technical points raised by Prof. PP of NIT (2) and others. Gasifier which could have been retrofitted to existing diesel engines was packaged along with a new engine. Gasifier-engine-pumpset/generator set was offered as a single composite product. This meant a substantial reduction in the number of gasifiers that could be supported within the budget of DFG. This change in packaging was adopted to overcome technical obstacles to the programme. The second was to price the product and determine the subsidy to be given in such a way to make this extremely attractive for the user, manufacturer and the field implementing agency. With the user having to meet only the cost of shed and civil works, the manufacturers and the field implementing agencies did not have to spend on market development. This step also enabled DFG to spend the budget allocated to it and show progress to the finance/ planning ministries. Mr. KS was under pressure to spend the finances that have been budgeted. Thus barriers to the innovation dissemination were lowered by changing the innovation package, its focus and a suitable pricing - subsidy policy.

This way the alliance was able to position the innovation so as to project a variety of benefits to a number of stake holders. The objective of initiating a new programme and exhausting the budget allocated was more important for DFG hierarchy. This is evident from the pressure on Mr. KS from Secretary and others. The redefined package could meet this. The innovators and the R&D committee were happy as some designs were going to the field. The manufacturers got a business opportunity. The positioning of the innovation so that every segment got some benefit was a key element in the strategy adopted by the alliance. This could not have been achieved if the partners to the alliance acted independently.

#### 4.6.4. Development of Dissemination Strategy

It would be interesting to study the strategy adopted by Prof. SM for dissemination of wood gasifiers before the alliance with Mr. KS was established in June 1986. He was attempting to establish the technological superiority and economic advantage of using gasifiers through extensive field trials. in order to undertake this, he gave up experimenting on petrol engines. He concentrated all his effort in getting funds from a number of sources for retrofitting his gasifier with existing diesel engines for long duration field trials. He made a proposal to DFG and to CST in early 86 and also got a project sanctioning 50 gasifiers for field trials from DFG. The field trials were planned to enable assessment of costs and benefits in adoption of the gasifier by the user. The strategy was based on a belief that

decision making by users (in this case DFG/CST) would be in a 'rational mode'.

The mode of strategy making and elements of the strategy changed significantly after the alliance was formed. Mr. KS being from the government, understood that decision making in the government is not based on the rational policy model. Most of the time, it is the organisational process that effects decision making. Sometimes it is the bureaucratic politics that matters. Hence a strategy made in the planning mode, with elements of a rational policy is unlikely to succeed. The strategy that was adopted by the alliance had the elements of (a) lowering barriers by packaging the innovation appropriately, (b) creating a vested interest network, and (c) fulfilling organisational (DFG'S) needs of new programmes and achievement. The alliance actively sought more supporters (manufacturers and nodal agencies) and created opportunities for the new supporters to benefit. It was a proactive search for new opportunities. The moves were controlled and coordinated by the alliance with power to manage the network concentrated in Mr. KS. The speedy dissemination was the sole goal. The alliance took substantial risks by adopting dramatic innovative moves, in the face of un+certainty. Clearly the alliance worked like entrepreneurs. The strategy was made in the entrepreneurial mode (after Mintzberg).

Prof. SM, before the alliance, was seeking approval for his innovation. The alliance however put together a programe, of which the innovation was a part, and was promoting the programme.

Another change that took place is the location of the strategy and its implementation. Before the alliance was set up in June 1986, the strategy was made at Vigyan in consultation with CST. The implementation was also effected at Vigyan. After Mr. KS got alliance with Prof. SM, the location shifted to Mr. KS. The implementation was effected through GASMACC and nodal agencies. The links which already existed between provincial nodal agencies and DFG for other programmes were used to implement this strategy also.

The gasifier was a new product with, at that time, not very clear benefits. Dissemination required a sponsor, who could provide the financial resources needed for subsidies and market development. Since DFG could be a sponsor, the strategy shifted to Mr. KS, who was chosen to the DFG decision process.

**4.6.5. Network**

In order to sustain the dissemination programme, it was essential to institutionalise a network and its functions in a formal way. This would enable the sustenance of the programme even after the champions withdraw from the scene.

Initiation of the network was attempted by Mr. KS sometime in September 1986 when he circulated the draft note on the dissemination programmes. He requested the various design groups to identify and link with manufacturers. Design groups were already linked to the DFG through research grants and some of them were members of R&D committee. The process of floating the

tender and finalisation of orders brought the manufacturers closer to Mr. KS. The nodal agencies at the provincial level had earlier links with DFG, in other programmes. Hence it was easier to institute a network. It was formalised when the DFG constituted a gasifier monitoring and coordination committee (GASMACC) with Secretary or in his absence Mr. KS as Chairman. The members included major research groups, all manufacturers, all field implementing agencies and a few individuals interested in the programme. The powers to add members were given to the Chairman.

The network was structured in a way that all the members had a direct, strong link with the DFG. Manufacturers in addition had links with the design group whose design they were producing. Links were also established between the manufacturer and the nodal agencies serviced by him. There was hardly any links across the manufacturers, or among nodal agencies or design groups. The structure of the network as existed in 1988 could be depicted as given in figure 4.3.

Only in the case of CST, which was also a nodal agency, a direct link existed with a design group at Vigyan due to CST earlier sponsoring the development of Vigyan gasifier.

Why was the network essential? The dissemination programme required a number of specialised tasks to be performed in a coordinated manner. The user had to be identified, his site and wood resources evaluated, the package of gasifier engine system

manufactured and tested, certified and installed. The user had also to be trained and after sales service provided. All these transactions could not be carried out through market mechanisms. As the gasifier was a new product, still untested in the field, it had a non-existent market. The market had to be developed through the DFG programme.

The programme required technology@ transfer, training of both manufacturer and user. The innovation was also not mature and further developments were underway. In such a situation a network is essential whether primed by government or by anybody else to perform the tasks of technology transfer, technology upgradation, training and trouble shooting. As long as there is requirements for these functions, a network will have to be maintained. The network may yield to market mechanisms at much later date.

The networks such as these are maintained by resource flows, information and knowledge flows, skill development and by a procedure of conflict resolution. The members to the network were chosen by (a) mandate of the rules or (b) by formal agreement or (c) by voluntary participants. The nodal agencies become members by their relationship with DFG which was earlier established by the rules of DFG. Manufacturers become members as part of their agreements with DFG and the design and R&D groups joined by voluntary participation. The basis of interaction was purely an economic exchange between manufacturers and others, as mandated by rules between DFG and nodal agencies and voluntary social

exchange process between design groups and others. The nature of

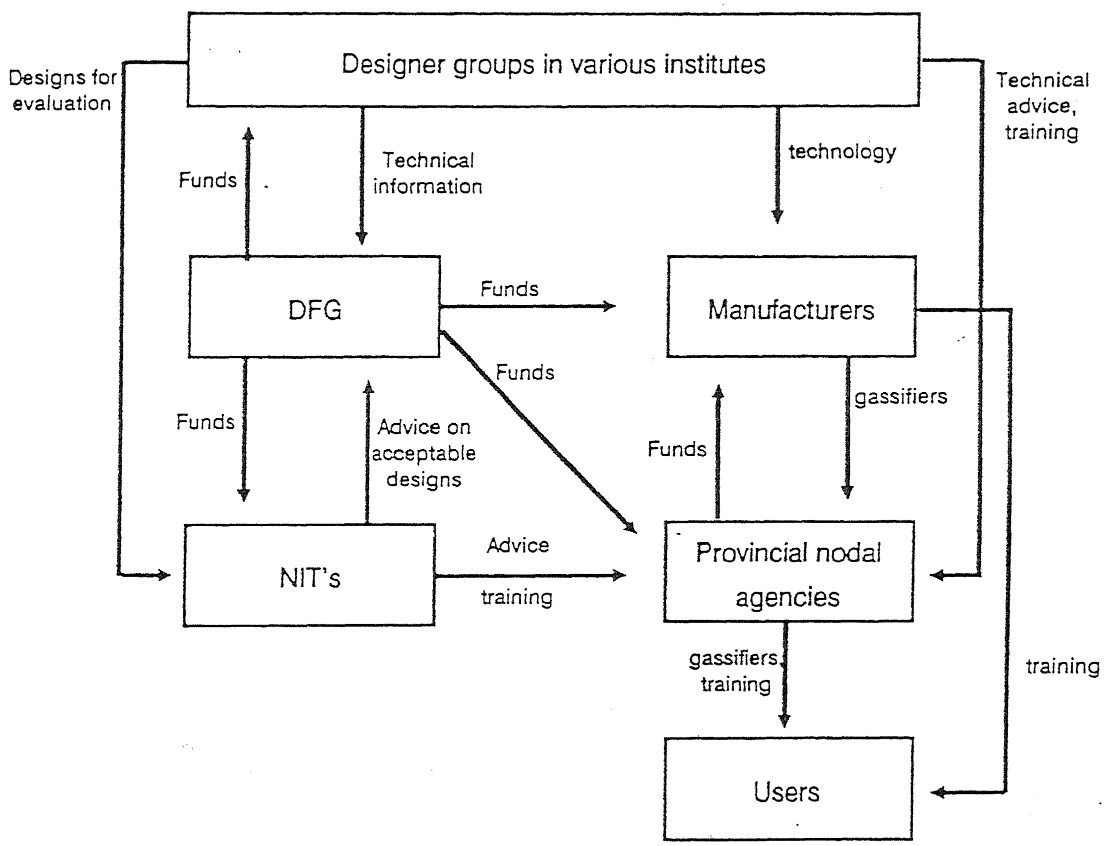


Figure 4.3 : Network of organisations for diffusion of gassifier

relationship was bureaucratic, in the sense there was a specialisation of tasks, the behaviour governed by rules and procedures of DFG and a hierarchy of roles with DFG at the top.

The information flow occurred in two ways. The committee itself met twice a year, where adequate time was provided for dialogue. The other was a communication between the members via Chairman. If the chairman felt that all members must be told off something, he resorted to letters, telexes etc. There was hardly any communication between members directly. The forum of the meeting of the GASMACC was used to strive a consensus on contentious issues, the final arbitration always rested with the DFG. In that sense GASMACC was an advisory committee whose recommendations to the DFG were not binding. The Chairman of GASMACC acted as the link between GASMACC and the DFG. In addition to this, the DFG helped to organise once a year a national technical meet on gasification where are all research groups were provided an opportunity to present results of their current research. The members of GASMACC were invited to such technical meets.

### 4.6.6. Changes in the Focus of the Innovation

The focus of the innovation at the beginning in 1981 was on the development of a wood gasifier that could be retrofitted into diesel engines. The objective was to reduce the consumption of diesel, by substituting diesel with wood gas. The scope was enlarged in 1982, to see the possibilities of running a petrol engine completely on woodgas. This is an important change as

petrol or kerosene engines of small power were really not in much use, especially in rural areas where wood resources were available. This indicates the desire on the part of the innovators to develop diverse use for their innovation. The gasifier could either be retrofitted to an existing diesel engine or sold in combination with a petrol/kerosene engine as an independent power pack.

In the review committee meeting of January 1986 two important suggestions were made by members. Prof. PP of NIT (2) wanted the group to revert back to diesel engines and give up petrol/kerosene engines. Another suggestion was made by CST representative to explore the possibilities of using agricultural residues such as corn cobs, cotton stalks. By that time Prof. SM had already initiated steps towards dissemination of gasifiers. We had seen earlier that he evolved a strategy, wherein field trials assumed significant importance. He was very keen to get some sponsorship for field trials. Accepting the suggestion to concentrate on diesel engine, would, in his perception, significantly improve the possibility of sponsorship. The suggestion had also emanated from a peer scientist working in the same area. Hence this suggestion was accepted.

On the other hand, the suggestion to try other non-woody material was not very crucial for the field trial phase. The suggestion was not taken very seriously. This narrowed the focus back to wood as material and diesel engine as the prime mover.

The next crucial change that took place happened in Sept.86, after the alliance was formed. The concept of retrofitting was jettisoned in order to initiate a programme of dissemination. We must note that the alliance had adopted an entrepreneurial strategy in which barriers are lowered, not by either a rational approach or by an adoptive approach, but by proactively creating different circumstances. Hence the objection to the programme due to non-availability of long term data was not met by waiting for the results of field trial projects or by providing gasifiers with some insurance in case of engine failure but by packing it with new engines, and implicating other issues like the achievement of targets etc. This strategy resulted in dropping retrofitting altogether. Retrofitting would have meant, use of different makes of diesel engines. Packaging with a new diesel engine meant narrowing down on only one make of diesel engine.

We can see that the focus of innovation initially got enlarged but later narrowed down to a single package. The changes, their acceptance or rejection were entirely dictated by the strategy of dissemination adopted by champions.

**4.6.7. Role of Small Groups**

A number of small groups have played significant role in the development and diffusion of gasifier technology. The executive committee of the CST, the review committee constituted by CST and the committee on gasification set up by DFG had made significant contributions.

We must note that the executive committee of CST did not extend whole hearted support to the development. Some members expressed reservations on the economics and on the environmental impact this technology could have. However they did not make an issue on it. The members of the executive committee consists some very senior government officers as well as very senior scientists. They all hailed from same economic and social group and some of them had relationship for long time. Groups like this would always protect their cohesiveness and image. Any differences among members would not be pressed very hard. Another reason for CST executive committee's support could be the strong support to the proposal extended by the Secretary of CST who was also the chief executive officer of CST. Secretary happened to be an eminent scientist with long standing relationship with most of the members of the group. This could have made the dissenting members to finally agree to support the proposals at various stages.

The review committee which met in Jan.86 to assess the progress of the project and to suggest future course of action, was a group with members enjoying varied status. It had four members of the CST executive committee (all scientists), a chairman of an agro industries corporation (an administrative senior officer), Prof. PP and Dr. PV of DFG. Prof. PP was the chairman of DFG gasification committee. We must also note that Prof. SM, who had taken up the championing role was moving closer to DFG to seek their sponsorship. It was also well known that DFG had much more financial resources than CST. This gave more

importance to Prof. PP and Dr. PV. This group met only once, but the objective of Prof. SM to get an approval for his plans of extended field trials was achieved. There were differences of opinion among members with respect to choice of engine (diesel or petrol or gas), choice of fuel (wood or agro residues) and on accessories. The decisions were recorded in such a way that gasifier with diesel engine and wood as fuel was recommended for immediate field trials. All the other opinions were also recommended to be tried by Prof. SM in the lab. For instance, the committee recommended that if a high efficiency gas engine was available that could also be tried. It was fairly clear that the views of Prof. PP had prevailed. There could be two reasons for this to happen. Prof. PP was an expert on engines and other members accepted her advice on this score. The second reason may be that acceptance of this suggestion would pave the way for getting a quicker sponsorship from DFG as CST alone cannot fund the entire field trial programme.

Another important group that moulded the gasifier programme was the national gasification committee constituted by DFG. This committee was constituted in June 1982 with Dr. SR as chair person. This was reconstituted in Feb.85 with Prof. PP as chair person. The committee headed by Dr. SR was constituted along with the AID sponsored research programme. These committees had scientists from few selected institutions as members. The officer incharge of the programme in DFG was its member secretary. It had generally six members including the chairman. The major responsibility of this group was to seek research proposals on

gasification, on use of gasifier and related issues from research groups, consider the proposals and recommend them to DFG for funding. The members of the committee themselves were in receipt of large fraction of funds of DFG as well as AID. This group met atleast twice a year. The member-secretary, a DFG officer, generally played the role of coordinator and most of the time emerged as the leader of the group. This group generally supported the proposals to develop gasifiers by a number of groups spread all over the country. Very rarely did it reject proposals. This could be seen from the fact that seven groups were supported in development of low power wood gasifier at one time.

This group, in evaluating gasifier designs and fixing standards for acceptance by the DFG for inclusion in the dissemination programme, was lenient and allowed a number of design gasifiers to come into the programme. It did not undertake a comparative evaluation of gasifiers. Among the members of the group Prof. SM and Prof. DG had their own gasifier designs. Other members did not work in the area of design. The chair person during 1982-85, Dr. SR was from a provincial energy promotion agency. Prof. PP who took over as chairperson in 1985, was involved in testing of gasifier and engines. The hard decisions of actual choice were left to Mr. KS of DFG.

There could be many reasons to promote multi locational development as well as for fixing low standards. We must note that the members themselves received a large share of funds of

DFG. Any rigorous evaluation of proposals leading to rejection of a number of them, would have led to an accusation of vested interest. The members, in one sense, were also competitors as they strive to establish their supremacy in the field of gasification and compete for the resources of DFG. In order to minimise threat to their positions, members supported most of the proposals. That could also get them supporters. As long as the DFG is able to sponsor all such recommendations, they had nothing to lose by a liberal attitude.

Mr. KS of DFG used his own ways of reducing the number of aspirants. By linking the dissemination programme to manufacture he virtually eliminated four designs as they could not find a manufacturer in time. The liberal attitude of this committee helped the alliance of KS and Prof. SM as they could fashion out a programme which could not be objected to by the gasification committee.

### 4.6.8. Multilocational Development

Why should DFG support development of gasifier by different groups at different locations, even when a few good designs have already emerged? DFG being a department of federal government is open to review and criticism by press, parliament and others. Functioning in a governmental set up requires spreading of the resources across regions. Research groups across the country depend on government for their support. It is essential for the department to procure support from all such groups. Hence some

resources are given to groups, even with the knowledge that nothing may come out of it.

This also creates competition for resources among scientific community and the relationship between officers of DFG and the scientists was more crucial than the merits of the proposal in determining the quantum of funding. These steps concentrates power on persons manning resource releases and not on the impartial evaluation system. Inclusion of all groups in government programmes rather than a strict evaluation is the path of least resistance. Alliances could flourish in such environment, as they can influence various evaluation groups.

In conclusion, the dissemination of gasifier was fashioned out by an alliance of champions by taking some imaginative steps in positioning of the product, lowering the barrier and fashioning a network.

## 4.7. LOW COST BUILDING TECHNOLOGIES

### 4.7.1. The Problem of Housing the Poor

A few members of the faculty of an Institute of Science (Vigyan) felt that problems of development of rural areas could be solved to some extent by application of scientific concepts and technologies appropriate to the context. In 1974 they came together to form a department for rural technologies (DRT). The Government of a province (PS) leased out a barren 54 acres in a semi-arid tract, 110 kms from the institute to be used by this group as a field laboratory and extension centre. This campus near the village 'Ring' became the centre of trials of various technologies. DRT organised a number of seminars and discussion meetings in 1974-75, to identify areas in which they should work. One area of common concern was the problem of lack of adequate housing in rural areas. Innovations to improve the quality of the structures subject to the constraints of utilisation of local materials and affordability were to be attempted. Even the building proposed to be constructed in the extension centre was to try out these possibilities.

In order to provide housing to the homeless poor in rural areas, the Government of the PS province launched in 1973 a massive scheme of building houses of 250-300 sq.ft each at a cost of Rs.2,500/- each. 30,000 houses were planned to be constructed in rural areas in that year. The beneficiary was provided with a loan of Rs.1000 and a grant of Rs.1,000/-. He was expected to pay

Rs.500/- either in cash or through his labour. The provincial Public Works Department prepared model plans to be used by executing agencies (Block Development Officers of talukas). Soon the government found that use of conventional technologies may not lead to provision of housing within the budget provided. Between 1973 and 1977 the cost of materials (even though of local variety) increased by 30%, leading to either a reduction in plinth area or more contribution from the user. The PWD had started to look around for low cost technologies and arrived at a few designs. These were exhibited in various exhibitions.

### 4.7.2. Initiation of a Research Programme

In 1975, a few scientists of the Vigyan, a few administrators and a few ministers met and decided to form a provincial Council for Science & Technology (CST). This body, an autonomous registered society, would provide a forum for exchange of information, ideas and possible technologies between scientists and administrators. The Chief Minister was to be the President while the Director, Vigyan, was to be the Chairman of its Executive Committee. CST identified housing to be an important area where appropriate technologies are to be developed. It constituted a working group in 1977 with Secretary, PWD (an engineer) as Chairman and Prof. SJ (DRT, Vigyan) as a member.

Even before constitution of this working group, Prof. SJ and his colleagues had done considerable amount of work in DRT. A

survey of rural housing needs and technologies was undertaken. Low cost houses exhibited by government departments in an exhibition in 1976 were evaluated. Properties of soil cement blocks were studied with a view to substitute burnt bricks with these blocks. Ferrocement roofs were considered as an alternative to the traditional tiled roof. A laboratory building was built using these technologies in 1976 at a cost of Rs.24/sq.ft. Compressed soil cement blocks were made using a ram known as Cinva ram. The group at DRT comprised Prof. SJ, Prof. SS, Prof. SN and Prof. TSI, all of them from the Civil Engineering Department. In addition to this Prof. SJ carried out development of a ferrocement hypar shell as a low cost roof. Though economical (Rs.85/sq.m), it was not considered to be useful as it required cement, steel and skills not generally available in rural areas. The group arrived at a few criteria to be used in the design of rural housing. They emphasised the use of local labour, local materials and lower cost. Using these criteria, they found the designs evolved by government departments like (a) hollow-block shell structure, (b) plywood roof, (c) mud house with bitumen coating as not appropriate.

This group had identified compressed stabilised mud blocks (SMBs) to be a good alternative to burnt bricks. Prof. SN and Prof. TSI studied the stabilisation process in soil cement blocks. They concluded that compactive effort plays by far a dominant role in improving the strength and durability of blocks.

The working group constituted by the CST met on 8 September 1977. Secretary, PWD, Prof. SJ, Prof. TSI and Secretary, CST

participated. It discussed the following topics:

(a) Survey of local architecture

(b) Low cost roofing tiles

(c) Manual soil compacting machines and

(d) Rammed earth constructions.

It was decided to sound a few people and solicit research proposals. The regional engineering college in the PS province sent a proposal on clay tiles. Prof. SN and Prof. AS of Vigyan sent a proposal on study of soils. Information was also collected by the CST secretariat on developments in this field in other parts of the country.

The working group of the CST reviewing the developments that had taken place both in the PS province and elsewhere decided to organise a two-day workshop of scientists, administrators, engineering college teachers and others, to arrive at a programme identifying technological gaps. The CST would then sponsor technology development projects based on this programme. Papers were presented by the a Chief Engineer, a district administrator and a number of scientists. A proposal prepared by the group at DRT with Prof. SJ as the team leader was considered by the Executive Committee of the CST on 22 August 1979. This proposal aimed at developing technologies for

(a) using soil, either through compacted soil blocks or through rammed earth, in foundation and in walls

(b) lime and pozzolana based cements

(c) using local timbers and

(d) roofing.

The emphasis was on use of local materials, lower cost and employment generation. The proposal required two years and a sum of Rs.1,70,400. While discussing this proposal the Executive Committee felt that it was too ambitious and wanted a phasing out of the activities. The Chief Secretary to the PS Government, a member of the Executive Committee suggested that use of pottery may be encouraged. One member felt that it is not always necessary to rely on local materials completely. The proposal was approved.

**4.7.3. Development of a Number of Innovations**

An interim report was presented to the Executive Committee in April 1980. The report indicated that

1. a new ram to produce compressed stabilised or unstabilised mud blocks was ready;
2. lime can be used to stabilise red soil but not highly clay soils;
3. burning of clay at $700^{\circ}c$ produces high quality pozzolana; however powdered brick is no good;
4. no satisfactory progress on roofs despite many trials;
5. bullock power could be used to run a ball mill to produce lime-pozzolana cement.

### 4.7.4. The Demonstration

The ram was further improved and named Vigram. In March 1981, barely 5 months before the end of the research project, Prof. SJ suggested field trials of Vigram machine by making 5 Vigram machines and giving them to a few users. He also wanted to build a school in a village and undertake training of masons. He needed a budget of Rs.28,000 for this field activity. Other members of the team (Prof. SS, Prof. SN and Prof. AS) now dropped out of the programme as most of research work on soils in which they were interested had been completed. It was left to Prof. SJ to develop the technology.

The Executive Committee approved the project but felt that it requires more clarity. An assessment of the capacity of the machine in relation to the actual needs must be done. The project team and the CST secretariat was requested to work out a mechanism for transfer of technology. The Committee felt that compressed soil block either with cement or lime stabilisation or without any stabilisation was then ready for dissemination in regions of the PS province where soils were suitable.

On 3 August 1981, a progress report on the research project was presented. An erosion test rig to study the rain erosion property of soil block had been completed. But tests were still to be done. Intergrinding of lime and clay pozzolana (surkhi) gave better results than mere mixing of the two. No satisfactory design of a bullock powered ball mill was visible due to gearing

up problem. 2 reports viz., (a) manual of soil block construction and (b) design of Vigram were published.

The research project started in 1979 was coming to an end. The major achievement of this project was development of Vigram and compacted soil block technology. Prof. SJ forwarded a proposal to extend the project till September 1982 at an additional budget of Rs.90,000. He hoped to complete (a) the erosion test, (b) water proof coating, (c) Vigram II for more compaction, (d) economic feasibility study of lime pozzolana, (e) modification to bullock powered ball mill and (f) roof panels. This was approved.

At the same meeting a revised proposal for demonstration of soil block technology was considered. This proposal incorporated the suggestions made in the previous meeting. The demonstration was to be spread over two and half years and would cost Rs.75,000/-. The project was divided into 3 phases. During the first phase 5 vigram machines would be fabricated and given to voluntary agencies for field trials. A site for a school building will also be selected. During the second phase a training programme for masons would be conducted. Along with the training programme the school would also be built. The third phase would concern itself with monitoring the performance of the buildings put up by the local agencies as well as user's reactions. This was also approved.

### 4.7.5. The Search for a Manufacturer

In November 1981 the Government of the PS province decided to establish a Department of Science & Technology at the Government Secretariat with the dissemination of CST technologies as one of the major business of the department. Secretary to the Chief Minister was to be the Secretary to the department and a reputed scientist the Additional Secretary. Prof. DK, a member of DRT, Vigyan was appointed as the first Additional Secretary on deputation from the institute. He tried to look for organisations in the government sector that would be interested in making Vigram.

The Implement Manufacturing Company (IMCO), a loss making organisation was identified. IMCO was set up by the PS province to make agricultural implements such as ploughs, tillers etc. It had started building bodies for the state transport buses and was looking for an entry into other areas. Mr. JS was the Managing Director of IMCO during 1982 and he felt that an entry into manufacturing 'appropriate technology' and 'renewable energy' devices would give his organisation some advantage. A team from IMCO visited the CST on 16 April 1982 for getting the rights for Vigram. The CST informed that it would charge no royalty or fee but no exclusive right can be given to IMCO. IMCO should make two machines and get them certified by Prof. SJ before it could market. It should also involve Prof. SJ in the project for a year. IMCO agreed to these conditions on 5th May. Later Mr. JS who had come from a federal government enterprise was repatriated

and the new Managing Director was not too keen to pursue this effort.

The design was formally released by the Vigyan to an entrepreneur (spouse of an employee of DRT) who already had an ancillary unit attached to a large public enterprise. A sum of Rs.10,000 was charged as technology transfer fee with a royalty of Rs.75/- per machine sold. The machine was expected to cost Rs.3,000 and about 300 blocks (equivalent to 750 burnt bricks) could be produced by a team of 3 labourers.

**4.7.6. Other Innovations**

The research project was closed in September 1982. The achievements were development of Vigram, technology for soil stabilisation and laboratory scale process for lime-rice husk ash surkhi pozzolana. But a large amount of work as proposed in 1979 were left incomplete. Among them were (a) rammed earth construction, (b) scaling up lime pozzolana and (c) alternative roofs. Prof. SJ indicated that he can still work on this. Phase II of the research project was started with a budget of Rs.1,25,400 for a period of 1 year. In September 1983 at the end of stipulated one year for R&D phase II project was over, a progress report was placed before the Executive Committee. The report indicated that lime-rice husk ash=surkhi cement would cost Rs.22 per bag. But no further progress could be made on ball mill. A roofing panel made of tiles and reinforcing rods was developed, but was not meant for rural use due to its cost. Prof.

SJ wanted the project to be extended till September 1985 to complete development of all technologies. This was granted.

### 4.7.7. Widening of the Scope of the Project

It was very clear in 1983 December that compacted soil block could be used in rural constructions under the governmental rural housing programme i red soil area of the province (nearly half the area of the province). There were no solutions to the problem of the roof. But the roof panel technology along with compacted soil blocks could be used profitably in urban areas. The roof panels could be used in two storeyed constructions also. It was decided to demonstrate this technology by building CST and DRT offices/library building. The Chief Secretary to the Government felt that attempts must be focused on problems of both urban and rural poor. He however felt that one could put up a building for CST's own use. The committee asked for redrafting of the proposal and sanctioned it at the next meeting during July 1984. The building was to cost Rs.85/sq.ft as against Rs.130-140/sq.ft if one used a conventional technology.

### 4.7.8. Adoption of Soil Block in Government Programmes

In March 1984, Secretary, DST, Govt.of the PS province, Mr. VB (also Secretary to Chief Minister) organised a meeting with a view to make government owned house building organisations accept soil-block technology. He invited the then Housing Commissioner (concurrently Managing Director of the provincial Housing Board), a representative from District Rural Development Society (DRDS),

Prof. SJ and CST. At this meeting it was decided that the provincial Housing Board would look for an area near the provincial head quarters to build 50 houses. The DRDS would identify 5 villages where this technology would be used to build houses under rural Housing Programme. In July 1984, DRDS requested for 5 machines one for each village. These machines were procured. But nothing much happened afterwards.

In August 1985 the work done under the research programme (1979-85) was reviewed. The new Chief Secretary felt that though all the R&D was not complete, some components could be transferred to the field. The Development Commissioner wanted the PWD to be persuaded. A dissemination plan of soil block technology was requested for. A committee with Development Commissioner as Chairman, Prof. SJ and Chief Engineer (PWD) was requested to prepare this plan.

This meeting was held on 29 November 1985. It was decided that CST would build 100 rural houses. The provincial Housing Board will build a few urban houses. Development Commissioner will ensure f??ding for this programme. The CST in consultation with Prof. SJ prepared a proposal to build 100 houses of 250 sq.ft each in collaboration with voluntary agencies, and government field agencies (DRDS). The houses will use soil blocks, roof panels and a lime soil plaster. The proposal also contained construction of few urban houses under the economically weaker section programme (EWS). The cost worked out to Rs.6,000/250 sq.ft in rural areas and Rs.40,000/500 sq.ft. in

urban areas. This was within the limit prescribed by the government. However government could not bear the cost of training salary of project personnel and cost of land scapping.

This proposal was discussed on 1 January 1986 at the CST Executive Committee meeting. The Chief Minister in his capacity as the Finance Minister (a member of Executive Committee) attended the meeting. The new Chief Secretary felt that one must concentrate only on rural housing and not urban housing. The Chief Minister felt that government must encourage multistoreyed construction in urban areas to lessen the cost of infrastructure and hence the alternative of compressed soil blocks should be disseminated in rural areas. The Additional Chief Secretary informed that the housing board is building single storey houses in smaller urban areas (not near cities) and they can use these technologies. Another member felt that if the technology is accepted by urban people, its spread in rural areas will be faster. The Chief Minister wanted the research to be undertaken into the problems of black cotton soil areas. The alternative technologies that have been developed so far could not be disseminated in those areas.

Keeping these in mind, 2 proposals were prepared. One attempted to look into the possibility of using black cotton soils to provide building material. The other was the earlier demonstration project without the urban component. The R&D project was approved. The demonstration project was approved and the Development Commissioner was requested to arrange for funds.

Later the department of rural development agreed to fund Rs.6,000 per house. The balance cost to be borne by the CST. As CST did not have adequate finances (of the order of Rs.2,00,000/-) for the other component this project was dropped. Another reason for dropping this project was interest shown by a public sector company in getting their housing colony constructed using these technologies. Eventually that also did not materialise.

Another attempt was made by the CST to make government programmes use these technologies. Houses were built by the government under Rural Landless Employment Guarantee Programme (RLEGP). Rs.8,500/house (including electrification, sanitary and latrine) was available. A meeting was organised with Director in charge of RLEGP on 24 July 1987. At this meeting it was proposed that 3 junior engineers in charge of housing will be trained by CST for one whole year. They would then build 25 houses each under CST's supervision. Prof. SJ wanted a panel of 6 to be set up for interview. 3 were sent and one was chosen to undergo training. But he did not report for training as he was transferred.

**4.7.9. Developments Elsewhere**

In October 1987, CST reviewed the progress in research projects (1979-87). The Building Research Institute of the federal government nominated a person to this review committee. This review committee directed that following must be completed before the end of research programme.

1. Development of Technology

    a. Prefabricated composite roof for rural use

    b. Improvement of Vigram to achieve a net strength of 20 $kg/cm^2$

2. Field testing and demonstration

    a. Production of lime-pozzolana in villages

    b. Stabilised blocks for black cotton soil.

Prof. SJ prepared a 2-year programme ending October 1989 at Rs.5,18,000/-. This was approved by the CST Executive Committee. The Chairman felt that the group must open out and interact with a larger number of voluntary agencies, private industries and others. Local institutions must be strengthened. He mentioned the work carried out by a group at another state.

Around the same time a number of organisations both in the voluntary sector and the government sector started experimenting with alternative building technologies. Prof. SJ himself was in constant touch with a few of the voluntary organisations. About 20 buildings had been put up by these organisations in a number of places in South India. Around the same time Mr. AK, who had completed his contract with an U.N. organisation set up Alternative Development, a NGO in Delhi with a view to develop, productionise and market appropriate technologies. He visited DRT and got interested in soil block construction. He borrowed one Vigram to try it out in the alluvial soils of gangetic plains. His group analysed the machine and made minor modifications. The new ram was named Adram and could make blocks both in alluvial

soils and red soils. The Alternative Development had a representative in PS province. Through him a few number of Adrams were sold to a voluntary agency working with tribals of a district. A few houses were built with the help of Adram.

Prof. SJ objected to Alternative Developments marketing a copy of Vigram without giving credit to Vigyan for the basic design. Mr. AK modified the sales literature and the name plate to include a credit to Vigyan. He wanted the PS government to promote Adram and was trying to get the Agro Industries Corporation to produce it. On March 11, 1985 Alternative Developments formally wrote to the government about Adram and another new machine. The blocks produced by Adrams were identical to those made by Vigram. The blocks produced by the second machine were similar to burnt brick in size. The government requested the CST to advise the government on this matter. CST requested the Alternative Developments through the government to send one machine each and few sample blocks for testing. This did not materialise. They however continued to promote these machines in other parts of India.

The National Building Organisation (NBO) part of the department of works and housing of the federal government encouraged universities to undertake both research and dissemination of alternative housing technologies. It set up a number of regional centres. One such centre was established in a University of PS state with Mr. KR of the Civil Engineering Department as its coordinator. This regional centre decided to

concentrate on soil blocks, ferrocement structures and other pre-fabricated items. Around the same time the Technical and Economic Consultancy Organisation of PS state (TEC) which was the organisation set up to provide assistance in consultancy to small entrepreneurs started a project in a district called Rural Industrial Development (RID). Mr. KR used funds available in this project to put up low cost structure. He also modified Vigram and named it RID-I, which was used in the project. He took on the role of actively promoting soil block construction in various government programmes.

### 4.7.10. Adoption of Soil Blocks by Federal Agencies

On 17 March 1986, Mr. KR organised an one-day seminar under the auspices of National Building Organisation on low cost housing technology. A number of government agencies and others took part. By this time due to efforts of a number of organisations, use of soil cement blocks had become an accepted practice. A large number of individuals building their homes started seeking help from DRT and the sale of vigram machine picked up.

At this seminar Prof. SJ made a presentation. The session was chaired by Mr. VS, Regional Chief of the federal Housing and Urban Development Corporation. HOUSECO is a federal undertaking set up in 1970 to promote housing. The corporation initially started working as a financing corporation providing loans to state housing boards and cooperatives for low income group housing construction. Over the years the corporation took

interest in settlement planning and was providing guidelines and training to state level officers in this area. Mr. VS was interested in expanding the role of the corporation even further to the area of promoting alternative technologies and materials. Mr. VS visited DRT subsequent to this seminar and started consulting Prof. SJ more often. He organised a national mud workshop in early 1987, where the Chairman, HOUSECO Mr. SKS participated. Mr. SKS, himself a keen promoter of new technologies, was attracted by some of the solutions offered by DRT and established a personal rapport with SJ.

HOUSECO took a number of steps between 1987 and 1989. Prof. SJ was nominated to various committees of HOUSECO. He was made a member of HOUSECO, Regional Technical Committee where proposals from various organisations including provincial Housing Boards was discussed. He was also made a member of technical panel for equipment assistance programme at the apex level. This panel consisted of, among others, Director, NBO, and Alternative Developments. Mr. SKS sought opinion of Prof. SJ on a number of technical alternatives (like rat trap bond, use of modular bricks, additives to cement etc.) during the course of association. The HOUSECO set up a permanent exhibition in a metropolitan city on alternative technologies on building materials. It was setting up a national habitat institute to train in habitat planning, technologies etc., at national capital. A habitat polytechnic was also on the way.

HOUSECO decided to promote these technologies also among private organisations and individuals. Already by 1988 around 60 private buildings had come up in and around the city where Vigyan is situated. Mr. Y, an engineer with Prof. SJ right from 1979 put up his house using these technologies, a two storeyed construction of 1600 sq.ft. He could secure bank loans. Mr. KTVA of HOUSECO also built his home with low cost alternatives. HOUSECO and CST decided to organise a two day exposure programme for all those who were interested Each participant was to pay Rs.250 for the literature. As against an estimated 250, four hundred attended the exposure programme, a number of them being architects and contractors.

The PS Housing Board, one of the clients of HOUSECO had also started using these technologies in EWS schemes. It started building about 700 houses in Yelahanka, 20 kms from the headquarter PS province. Prof. SJ was informally consulted in the initial phases. HOUSECO decided to formally accept these alternatives and promote them in a large measure.

**4.7.11. The Diffusion Process**

In 1986 Collector of a district in another province felt that low cost, employment generating technologies could be used in the government housing programme. However, there was a lack of trained manpower as well as shortage of prefabricated low cost building components. He set up a registered society called Nirmiti Kendra which fulfilled these needs. This became self sufficient in a very short span of time.

HOUSECO followed up its earlier decision to promote these technologies developed by various groups, by suggesting to all PS governments the establishment of nirmiti kendras in all districts. HOUSECO was ready to provide about Rs.2 lakhs/yr as grant for a few years. PS state set up such kendras immediately. Each kendra was registered as a society and had Chief Secretary of the Zilla Parishad as Chairman. It had principal of the local engineering college as Vice-Chairman. The Project Manager of the Nirmiti Kendras was an Engineer who was paid a salary of Rs.2,000/- p.m. Nirmiti Kendra in the PS state had to compete with Land Army Corporation, a government undertaking of ex-servicemen engaged in construction and with local contractors. The governing board of these kendras could not meet as often as necessary since most of its members were quite busy in their respective jobs. The project manager was not adequately trained and was too junior to interact with his counterparts in government. Due to these reasons, the success of the first nirmiti kendra could not be repeated.

### 4.7.12. The Diffusion in the Voluntary Sector

In early 1985, Mr. BK, then Director General of Council on Rural Technology (CORT) visited DRT. CORT had been set up by the federal government to provide financial assistance to voluntary agencies to further the cause of rural technology. Mr. BK was impressed by the work of DRT, especially its work in the area of housing. He invited DRT to send a proposal for field trial and training in the area of housing. Mr. AJ, an administrative

service officer, was the Deputy Director General of CORT. A few meetings between him and Prof. SJ cemented a relationship which went further than mere providing of funds to DRT. CORT set up a building construction committee, under the convenership of a voluntary agency. The committee consisted of SJ, a representative of Alternative Developments and two more members who were from voluntary sector. DRT and Alternative Developments were the only technology developers in the committee. Other developers like Building Research Institute or National Building Organisation were not included. This committee had three meetings during 1986 and laid down the policy for selection, appraisal and evaluation of rural housing projects to be funded by CORT. CORT also utilised the services of Prof. SJ to visit and advice various voluntary groups funded by CORT on rural housing.

**4.7.13. The Diffusion of the Innovation to Private House Builders**

There were a large number of requests to CST and DRT for training of engineers, architects, masons and others in these technologies. Requests came from nirmiti kendras, land army corporation, voluntary agencies, contractors associations etc. The Reserve Bank had established as a wholly owned subsidiary the Housing Bank. The HB was to be a refinance institution providing finances to housing finance corporations. The main objective was to stimulate housing construction in the private sector. Besides t?? HB was also willing to participate in the equity of private housing or housing material companies or provide loans to them. Mr. S was its first Chairman. He visited DRT at the instance of

HOUSECO Chairman Mr. SKS and felt that these technologies could be used by private sector. The HB constituted a building material advisory committee to scrutinise proposals from building materials companies. Prof. SJ was made a member of that panel. The HB was keen that a regular training be organised to train about 100 engineers/contractors/architects per year in alternate technologies. In October 1989 at a meeting it was decided that 6 programmes per year would be organised. 15 engineers/architects will be trained for a period of 19 days. 5 of them will be sponsored candidates paying Rs.2,000/-. About 8 or 9 unemployed persons and one or two engineering college teachers would complete the class. The teachers would not pay any fee. The unemployed will not pay the fee and would receive a stipend of Rs.600/-. Research, development and consultation will be continued. This programme would be for a five year duration. Two third of the costs would be granted by National Housing Bank and one third by the CST. The first training programme commenced on 1 January 1990.

The R&D programme extended till October 1989 was completed. A better Vigram, named as 'VIGPRESS' was licensed to be made by a firm Village level production of lime pozzolana (capacity 100 bags a month) was set up at Ring village. But no success was possible with black cotton soil. Ferrocement roof panels that could be cast in situ and used in villages developed and tested at another village.

## 4.8. LOW COST BUILDING TECHNOLOGIES - ANALYSIS

### 4.8.1. Innovating Stages

This project did not concern itself with a single innovation. What was attempted, was a number of innovations, for various parts of the building. A technology for production of soil blocks that could be used instead of burnt bricks in wall construction was the chief among them. In situ cast or pre cast roofing panels either using ferrocement or tiles was another innovation. Attention was also paid to develop an alternative low cost cement using lime, rice husk ash and burnt clay. Of the three, the stabilized mud block technology (SMB) was developed to a stage where it was considered worthy of dissemination. The roof panels (RP) and the alternative cement of lime pozzolana (LP) did not go beyond development at laboratory and a few demonstrations. There has been an uneven attention on each of these efforts.

The project started formally in 1979. But work on low cost housing technologies had started in DRT, Vigyan right in 1976. If we adopt the innovating function framework of Pelz, the functions of concern and search were carried out between 1976 and 1979. In fact criteria of low cost, use of local materials and local skills were used to evaluate the options identified during the search. The activities falling under the 'design' functions were initiated in 1979. In case of roofing panels and alternative cement, the functions of design of solutions were conducted, sporadically, right through the decade of 1979-89.

We have noted earlier that criteria of low cost, local materials and local skills were used by Prof. SJ and his associates to evaluate solutions. A hypar shell roof designed by Prof. SJ earlier to this project was not promoted as it did not meet with this criteria. Prof. SJ and his team could not come up with any solution to the roofing problem that could pass these criteria. The insitu-cast or pre cast roof panels was the solution that could meet the stipulation for use in <u>urban areas</u> but not in rural areas. The roofing panels were cheaper than conventional RCC roofs and could be made using materials available in cities. The material needed were steel rods, steel mesh, cement and tiles. Since the focus of the project initially was on providing better technologies for rural areas, this technology could not be developed further. The other stages of innovation could not be completed with respect to the roofing technologies.

The case of alternative cement was different. The technology of producing a cement by intergrinding of lime, rice husk ash and burnt clay (surkhi) was proven in the laboratory in 1981 itself. This process passed the criteria of low cost, use of local materials and local skills. But further developments in pilot plant scale or operational scale was not taken up till October 1989 when a plant to produce 100 bags/month of the LP cement was set up in the 'Ring' village. The amount of time spent by the innovating team on the LP cement between 1981 and 89 was quite low.

An explanation to this could be found in the activities related to stabilised mud block (SMB) technology. The SMB technology was used by DRT, Vigyan in 1976 itself for building a laboratory building in the campus of Vigyan. At that time Prof. SJ used a commercially available Cinva Ram to make the soil blocks. Prof. SJ had initiated steps towards designing a cheaper and better ram. This ram, Vigram, was perfected by March 1981. Prof. SJ who was now ready with a product, initiated steps concerning with 'seeking commitment' immediately. The executive committee of CST also felt that SMB technology was then ready for dissemination. The major concern of Prof. SJ d his team was on dissemination of SMB technology, which meant little attention to LP cement.

It is perplexing to note that neither Prof. SJ nor CST made any attempt to enthuse any other member of Vigyan to pursue the LP cement process. It is difficult to hazard a guess in the absence of data. We may however record two facts. The development of LP cement required skills drawn from chemical engineering field. Prof. SJ belonged to the civil engineering department of Vigyan. Secondly amount of cement used in any rural home was little as cement was essentially used for plastering only.

We have already noted that function concerning seeking commitment regarding SMB technology was taken up in 1981. Attempts were made to promote SMB in four different 'markets': (a) non-governmental organisations engaged in rural development work, (b) governmental rural housing programme, (c) governmental

urban poor housing programme through housing boards and (d) private citizens in urban areas building their own houses. In each of these markets the functions of trial implementation, incorporation and diffusion was performed in a muddled way by a number of agencies between 1981 and 1989. Though acceptance of SMB by these markets have considerably increased after 1987, when House Co. and CORT entered the scene, it cannot be said that the diffusion is complete. The rate of absorption of this technology in these markets are different.

#### 4.8.2. Champions

Prof. SJ emerges as a champion of Stabilised Mud Block (SMB) technology and to a lesser extent the roof panel (RP) technology. From 1981 onwards he was championing the dissemination of SMB. He initiated the moves for dissemination by proposing to the CST to demonstrate SMB technology by building a school building. He also proposed to involve the voluntary non-governmental organisations (NGOs) engaged in rural development in the dissemination process. He assisted a large number of citizens in building their homes with SMB and RP technologies. By 1987 around sixty buildings were constructed through private efforts. Prof. SJ used every forum available to propagate the innovations. In the five year period between 1982 and 87, he helped by training and supervising construction of 20 buildings by NGOs. Though he was attempting to disseminate the innovations in the NGO and private markets, he was willing to cooperate with governmental organisations. This is evident from the support he gave to the efforts of CST in

disseminating the SMB innovation in the governmental rural housing programme. He did not let go, the opportunity to forge alliances with Mr. VS of Houseco and Mr. AJ of CORT in furtherance of technologies.

Mr. VS of HOUSECO emerges as another champion of these technologies. He helped to enlarge the scope of HOUSECO from merely a housing finance company to that of a company promoting rational planning, appropriate technologies and materials. He initiated activities leading to setting up of a permanent exhibition, national habitat institute and nirmiti kendras. He exhibited a high risk taking behaviour by promoting technologies which had not been widely tested in a variety of climatic and soil conditions. He procured the resources of HOUSECO for furtherance of this objective. He took the initiative in forgoing an alliance with Prof. SJ of Vigyan. By keeping his links with other technology groups like NBO, alternative development, the HOUSECO could benefit from a number of ideas.

Mr. AJ of CORT played a significant role in promoting SMB and other related technologies in the NGO sector. Though the initial handshake with Prof. SJ was with Mr. BK, director general of CORT, the subsequent developments were fashioned out by Mr. AJ. The constitution of the building committee and a scheme to assist the NGO sector was worked out by AJ, in alliance with Prof. SJ. We must note that the developments at HOUSECO and CORT went on parallelly. Prof. SJ was the common element in these activities. We cannot clearly say whether the activities of CORT were influenced by the initiatives of HOUSECO.

### 4.8.3. Alliances of Champions and Strategy of Dissemination

We have already noted that SMB and RP technologies had four distinct markets. They were (a) non-governmental organisations (NGOs), (b) governmental rural housing programme, (c) provincial housing boards and (d) private citizens in urban areas. During 1986-87, two alliances of champions emerged. One was between Prof. SJ and Mr. VS leading to evolution of a dissemination programme by HOUSECO. The other was between Prof. SJ and Mr. AJ leading to a programme in CORT. Before the emergence of these alliances certain steps towards disseminating SMB and RP technologies were adopted by Prof. SJ and CST. They were not very successful.

Between 1981 and 1986 Prof. SJ had attempted to disseminate these technologies in the NGO and private citizen market. Information about new technologies was spread in these sectors essentially by word of mouth, lectures in a few seminars and by actually building a few structures. There was no attempt to launch a well coordinated publicity campaign. The second element in the dissemination was to assist seekers of these technologies (a) by training their own manpower or by providing trained manpower available through earlier training (b) limited supervision of construction and (c) helping in procurement of vigram as testing the soil suitability. No assistance was provided in procuring finances. No efforts were made to develop entrepreneurs who can take up turn key contracts. SMB and RP technologies required a very close supervision of the process of

making blocks or panels. A small deviation in quality could lead to cracks in the building. No procedures for quick, on the site testing of SMB or RP was available. Despite these difficulties, the dissemination did take place at a slow pace. Nearly 60 buildings were constructed in these two markets by 1986-87. The strategy of dissemination adopted by Prof. SJ seems to have been made in an incremental way, each small step as a response to the environment and each step not too different from the earlier one. To use Mintzberg terminology, the strategy was evolved in an adaptive mode.

The executive committee of the CST decided in 1982 that SMB technology was ready for dissemination. It wanted the technology disseminated through the rural housing programme of the government. The rural housing programme under various budget heads was executed by the District Rural Development Societies (DRDS), a government undertaking. The DRDS had an engineering sub division to provide technical knowledge, supervision and inspection of all construction works. The engineers to this group were drawn from the provincial public works department (PWD) which provided technical drawings and standards. In fact one member of the CST mentioned that PWD must be persuaded to accept SMB. The CST executive committee was divided in its opinion about the applicability of SMB in urban housing programme where some felt multistoreyed tenements would be more suitable. After some discussion, they identified EWS scheme executed by the provincial housing board in small towns as an ideal segment for

dissemination of SMB. Hence CST mounted efforts to make DRDS and provincial housing board to accept the SMB technology.

The strategy of dissemination in these two sectors essentially revolved around getting the approval of these two (DRDS and housing board) organisation accept SMB in their regular programmes. The good offices of the Secretary to CM and Development Commissioner, who were members of CST were used to organise meetings and discus proposals. The strategy was built around demonstration of cost effectiveness by actual construction of a few houses by CST for these two organisations and training of their manpower. Proposals were made keeping in mind the existing norms of these organisations. We could clearly see a satisficing behaviour and the strategy being made in the adaptive mode. This did not work as finances for training and other overheads could not be provided by DRDS or HB. The CST was also starved of funds.

The strategy was made in the absence of an understanding of the organisational process of these organisations. Too much faith was placed on the cost effectiveness of the SMB technology and the support received from the top echelons of the administration. The hierarchy of a provincial administration is not as rigid as the chain of command in say, the army. Each field department enjoys a certain degree of autonomy owing to their specialised responsibility. These organisations have links with others (DRDS with PWD and provincial housing board with HOUSECO) for technical knowledge, personnel training and for funds. These links are much

stronger than their links with the administrative secretariat for adoption of new technology. An adoptive strategy in the absence of sponsorship from a key organisation, fails to achieve its objective.

Let us now look at the strategy evolved by Prof. SJ-VS (HOUSECO) alliance for implementation by HOUSECO. Among the elements of the strategy was first to make HOUSECO commit itself for SMB technology. This was done by bringing Prof. SJ in to the committees of HOUSECO. Another element in the strategy was to identify those who influence the private citizen market (architects, contractors and engineers) and evolve a methodology of training them. Exposure programmes, seminars etc., were organised by HOUSECO itself. HOUSECO also enthused the housing bank and CST to organise regular training programmes for these influencers. The third element in the strategy was to popularise SMB through advertisements as well as the permanent exhibition. Another innovative element of the strategy was the concept of nirmiti kendras. By using its earlier links with provincial housing banks and through the network of nirmiti kendras, the alliance established a wider network which would have stake in the dissemination. The constitution of nirmiti kendras indicates the attempt to rope in engineering colleges, district administration and others. However at no point of time there was any analysis of costs and benefits of this dissemination strategy nor was there any rules for evaluating the choices. For example the concept of nirmiti kendras though innovative, was not an outcome of careful analysis of alternatives. Similarly training

programmes were launched without estimating the demand for trained manpower. There were uncertainties regarding the acceptance of SMB by private citizens. There were also uncertainties regarding costs and benefits in different regions. Yet the alliance made bold innovative moves for promotion of SMB. The location of the strategy also shifted from Prof. SJ at Vigyan to HOUSECO. We can conclude that there was an entrepreneurial mode of functioning in evolution of this strategy.

We could view the strategy formulated by the alliance of Prof. SJ and AJ for implementation by CORT as an element or part of the strategy evolved by Prof. SJ and VS for HOUSECO. The HOUSECO strategy was aimed at the citizen and the government markets. The strategy of CORT looked after the NGO market. The HOUSECO provided loans to provincial housing boards. It, through NHB initiated provision of loans for low cost housing to private builders. On the other hand NGOs always look for grants. The CORT funds were used to provide such grants. CORT had, through its other schemes, established a wide range of contacts in the NGO sector. These contacts were used to promote SMB technology. Prof. SJ being the common man in these two organisations, helped in formulation and implementing dissemination strategies that were complementary to each other.

The case shows that initiative for forming alliances came not from the innovator, but from persons (VS and AJ) in the federal programming and financing organisations. They could have formed alliances with any technology provider, NGO or Building

Research Institute or Alternative Development. But they choose to ally with prof.SJ. One of the reasons may be the pre-eminent position Vigyan occupied among technological institutions in the country. The second reason may be that no other innovator championed the cause of SMB as much as Prof. SJ. Between 1982 and 1986, Prof. SJ was instrumental in getting about 60 buildings constructed. This track record made the work of alliances simpler.

**4.8.4. Changes in the Focus of the Innovation**

When the work on the project started in 1979 the project had a clear focus of developing low cost technologies using local materials and local skills for use in rural areas. The target market was the rural housing programme of the government. In fact certain technologies like Hypar Shell were rejected as unsuitable for rural areas. But as the technologies started emerging, this narrow focus was relaxed. SMB technology and Vigram were perfected in 1981. Prof. SJ initiated attempts to disseminate these technologies in rural areas through non-governmental voluntary organisations. The CST tried to get them to the governmental rural housing programme. But when he saw the potential of SMB technology in the urban, private housing market, Prof. SJ initiated activities to penetrate this segment. The group could not develop any roofing technology for rural areas that would meet with the criteria of local material and local skills. But the precast roofing panels (RP), developed by the group was eminently suitable for urban areas. Hence Prof. SJ

proposed in 1985 to enlarge the project to include demonstration in urban areas too. After some debate the CST agreed to enlarge the scope. This was further strengthened by the HOUSECO strategy, and in fact nearly 90% of buildings constructed using this technology till 1989 were in urban areas only.

There were similar change of focus of development of technologies themselves. When the work started, the development included SMB technology, rammed earth wall, roofing panels and alternative cement. Once the SMB technology was perfected, work on development of rammed earth was given up. We had already noted the uneven attention paid to development of LP cement. This shows very clearly that dissemination of developed technologies took the priority and all attention was on SMB and its dissemination.

SMB and RP technologies were difficult to disseminate. Their major advantage was the lower cost SMB technology, for instance reduced the cost of wall construction by 30%. However, walls themselves cost only 30-35% of building cost. Hence overall cost reduction in adopting SMB technology was about 10%. If a builder adopted both SMB and RP, and also used other efficient building practices, he could save 25 to 30% of the cost of the building. If we keep in mind, that housing is once a lifetime decision for many individuals, saving of cost by 10% by adopting, yet widely not practiced, SMB was not very attractive. Besides this, masons and others had to considerably change their practices which necessitated training. The levels of supervision and monitoring was also pretty high. In such situations, faster dissemination

requires a strong sponsor. Innovators do not mind changes in the focus of innovation if required by sponsors or by the developers of the market.

### 4.8.5. Interorganisational Relationships

Dissemination of SMB and RP technologies required a number of tasks to be performed. Architects, contractors, engineers and masons had to be trained. Finances either as loan or as grant had to be arranged both for private individuals as well as provincial housing boards. Entrepreneurs making vigram machines had to be encouraged. Advertising of the concept had to be undertaken. These functions were organised by the Prof. SJ-VS alliance by inducing a number of inter organisational relationships. A relationship between housing bank and CST-DRT enabled organisation of training programmes, on a continuous basis. The housing bank's relationship with both public or private housing finance organisations led to provision of loans to both entrepreneurs and home makers. HOUSECO took care of the awareness creation through seminars, exhibitions as well as media advertising. The provincial housing boards were given loans by HOUSECO. There were three sets of relationships (a) HB-CST-DRT, (b) HB-Housing financing companies and (c) HOUSECO-PHBs. An overall view of all the relationships is given in Figure 4.4.

These relationships were established due to the nature of specialised tasks. The relationships were maintained primarily through the flow of financial resources. There were no attempt to

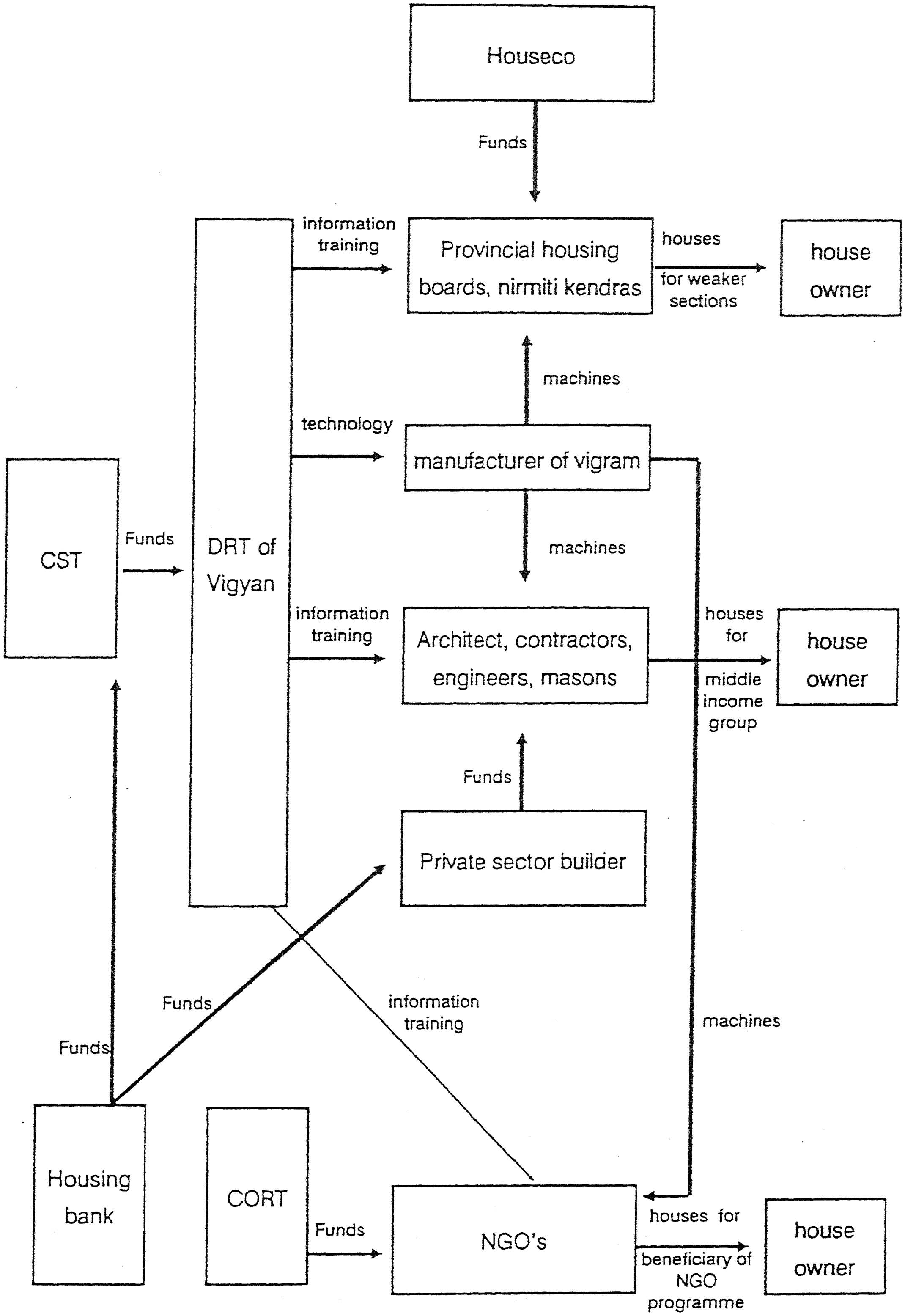


Figure 4.4 : Inter organisational relationships in the diffusion of housing technologies

link all of them in a network with a common programme. The demand for the services to be provided, in case of training and private home building were left to the market mechanism. Provincial housing boards were also given the freedom to use or not to use these technologies. No special scheme was formulated either by housing bank or HOUSECO.

The relationships were managed as per the provisions of formal agreements between organisations. Since there was no special programme with a mandate, there was no special attempt to coordinate or monitor the performance of these organisations.

**4.8.6. Role of Committees**

Three committees, executive committee of CST, a committee at HOUSECO and a building committee at CORT were involved in this case. The membership of the CST executive committee was determined by the constitution of CST, whereas the alliances of Prof. SJ with VS and Prof. SJ with AS influenced the composition of the committees at HOUSECO and CORT. One important role performed by these committees was to legitimise and support initiative taken by Prof. SJ and his alliances. The composition of the committees at HOUSECO and CORT included a few other technologies providers such as NBO, Alternative Development, Building Research Institute etc. The second major function performed by these committees were to win support of all technology groups for their programmes and to minimise the dissent among scientists. A sense of participation by all groups were to be ensured. Both these functions are essential to remove

any barrier that could come within the organisation and to secure the commitment of resources of the organisation.

These committees however did not attempt to fix performance or design standards nor there was attempt to evaluate various designs of soil block presses etc. It seems these were not undertaken in order to prevent dissent among technology groups.

**4.8.7. Multilocational Development**

Technology of SMB, RP and machines for them were developed at DRT, Vigyan (sponsored by CST), NBO, (sponsored by works and housing ministry), Building Research Institute (sponsored by federal council for scientific research) and Alternative Development (sponsored by a number of donors). There were contacts between the groups as could be seen by the nominee of the building research institute being on the review of Prof. SJ's project and Alternative Development's modification of vigram. These contacts however did not lead to evaluation of each others work. The groups all worked in isolation and did not benefit from each other. This may be due to (a) geographical distance, (b) multiplicity of sponsors and (c) the nature of the institutions themselves. It could also be due to professional rivalry.

This situation could have been avoided if sponsors were linked by mutual contacts and visits. The research sponsoring organisations had no links with each other leading to some duplication of work.

#### 4.8.8. Conclusion

This case shows that an entrepreneurial strategy formulated by an active alliance of champions, incorporating changes in focus of the innovation and establishing inter-organisational relationship could succeed even when economics is not conducive to quicker diffusion.

## 4.9. SILICON

### 4.9.1. Early Work at Vigyan

Prof. VM and Prof. GS of an institute of science (Vigyan) have been working in the area of preparation, analysis, characterisation and evaluation of electronic materials for over 3 decades. They have published widely and are recipients of many awards. The efforts over the past three decades have been successful in standardising the methods of preparation on a laboratory scale several silicon based materials. These include (a) Silicon tetrachloride, (b) Trichlorosilane, (c) Silane, (d) Methyl chlorosilanes, (e) Ethyl silicate, (f) Fumed silica, (g) Silicon nitride, (h) synthetic quartz crystals by hydrothermal technique and (i) electronic grade high purity silicon. All these items are in great demand in the country to meet a variety of growing industries. These chemicals have been prepared starting with the raw materials available in the local market and produced indigenously. No foreign exchange is involved in the procurement of raw materials like ferrosilicon (of different grades), metallurgical grade silicon, chlorine, methyl chloride, hydrogen chloride, hydrogen, industrial alcohol, etc. All these are available in tonnage quantities.

The technical 'know-how' generated at the Vigyan by Prof. VM and his colleagues for the preparation of some of the silicon materials had been transferred to industry for commercial exploitation. In collaboration with Vigyan, M/s MECHICO (now

merged with CHEPLAS Ltd.) (President Mr. RVR an alumnus of the institute) have built during the last two decade manufacturing units for silicon tetrachloride and ethyl silicate-40. The licensed capacity for the production units is around 1000 tons each per year. The production units were built indigenously based entirely on the Vigyan 'know-how' and on the components available in the local market. Almost all the machinery and fabricating devices were from within the country. The quality of these products conform to international specifications and the cost is competitive in the world market.

**4.9.2. Need for National Silicon Facility**

During the late seventies there was a rapid expansion of electronic industry within the country. The oil shocks of seventies forced the policy makers to look for alternate sources of energy. One such source is the sun whose radiation could be converted to electricity through photovoltaic cells. Both electronic industry and the photovoltaic cell manufacturers required high purity silicon. It was natural for Prof. VM, his associates and MECHICO turn their attention to the process for manufacture of high purity silicon. High purity silicon could be made either from silicon tetrachloride or from trichlorosilane or from their mixtures. Since MECHICO have already been producing silicon tetrachloride, this team developed a process of hydrogen reduction of silicon tetrachloride. MECHICO got a letter of intent to produce high purity silicon. They put up a pilot plant to try the Vigyan process in March 1982.

In view of the growing importance of silicon, which is a crucial raw material in the electronic industries, the Federal Department of Electronics (DOE) proposed in October 1981 the setting up of a National Silicon Facility (NSF) to undertake stock-piling, production, research and development so that the country could become self-sufficient in this critical material. This was approved by the government in November 1981 and a Task Force (TF) of specialists, including Prof. VM was constituted in January 1982 to configure the NSF for investment proposals.

The TF had concluded in August 1982 that the Silicon Tetrachloride (STC) feedstock was not suitable since the quality of silicon produced therefrom was poor and instead recommended Trichloro Silane (TCS) as feedstock. The STC feedstock was the one adopted by MECHICO, who had been issued in March 1982, with the industrial license for production of electronic grade silicon and silicon wafers.

The TF submitted Part I of its report in August 1982, suggesting the production process to be adopted and setting up a Negotiating Committee (NC) to finalise the? collaboration proposals. The TF also assessed that the national demand for silicon would be 100 tonnes per annum (TPA) by 1990. No further part of the report was submitted by the TF. However Prof. VM expressed his reservation on this report and observed that it was not necessary to go in for foreign collaboration as the technology is already available in the country.

### 4.9.3. Choice of Technology

The NC appointed in January 1983 considered the technology transfer offers of three foreign companies, without any global tenders being floated and recommended in December 1983 conclusion of technical collaboration agreement with HSC Corporation (U.S.A.) for setting up a 100 tonnes silicon plant, with possibilities for expansion to a 200 tonnes plant at a project cost of Rs.65.75 crores. According to the NC, the estimated demand for silicon could be 190 tonnes in 1988-89 and 230 TPA from 1990-91. The cost of silicon from this facility was estimated to be around Rs.2400/kg, while the cost of silicon to be manufactured by MECHICO was estimated around Rs.850/-.

After Electronic Commission (EC) had recommended the NC proposals in February 1984, the DOE put up a proposal to government in March 1984 for a 200 tonnes plant at a cost of Rs.90.75 crores with foreign exchange component of Rs.23 crores with technical collaboration from HSC. The DOE had recommended 200 tonnes plant since the incremental capital cost for higher capacity plant was marginal and a larger plant would reap economies of scale. The proposal was approved on 29 March 1984.

The agreement with HSC was signed on 16 April 1984. As per the agreement, a lumpsum fee of US $6.70 million was payable for process know-how, basic engineering documentation, etc. and US $ 7.65 million for proprietary equipments. In all, US $ 14.35 million (approximately Rs.18 crores) was payable in installments.

In addition, Rs.70 crores was to be spent towards indigenous equipments, buildings, land etc. for setting up the NSF. The production was to commence after 48 months.

HSC obtained the necessary export license from the US Government in January 1985 and thereafter the agreement was confirmed by the DOE on 18 February 1985. Until June 1987, the first two installments of Rs.2.93 crores had been paid to HSC. In addition, Rs.1.56 crores were paid as Income Tax on behalf of HSC and Rs.15.84 lakhs were paid to an engineering firm as consultancy charges for NSF configuration.

#### 4.9.4. Resistance from MECHICO and Vigyan

However both MECHICO and the Vigyan continued with their efforts in getting MECHICO technology approved. Nearly 95 tonnes of the estimated demand of 100 tonnes were to be used in the photovoltaic sector. Since the cost of photovoltaic cells were very high, they were completely subsidised for the user by the government. This was done through a federal department in charge of renewable energy (DFG), which had been set up in 1982. The photovoltaic programme was coordinated by Dr. GR who was an Assistant Professor at Vigyan some years back. Demand for silicon for photovoltaic application would directly depend on the budgetary allocation for this programme. The department was also interested in promoting indigenous development of technology for both crystalline as well as amorphous silicon. Dr. GR was sympathetic to the process developed at Vigyan.

The TF had rejected STC feedstock on the ground that the samples at MECHICO had not been fully characterised and therefore the product remained to be proved. However, just before the agreement with HSC confirmed in February 1985, an Evaluation Group appointed by the DFG and reports of testing from a U.S. firm had concluded that the purity of MECHICO silicon as produced in the pilot plant measured in the sample supplied was good for photovoltaic (PV) application and for some electronic devices as it had come close to the specification given by DOW Corning and SMIEL (the two internationally known producers). The Evaluation Group had further opined that MECHICO technology was likely to make further improvements and was expected to reach the highest international standards.

M/s MECHICO had also earlier sent their silicon for test report to M/s Silitech, California and their report of January 1985 stated that "we have measured the poly crystalline silicon from MECHICO, using the equipment we keep at MIDAC and we were impressed with its purity. The material we have seen is fully the equal of any made by the large poly suppliers". Thus, the quality of silicon produced by the indigenous producer had been established before the agreement with HSC Corporation was confirmed in February 1985.

**4.9.5. The VR Committee**

Prof. VM and Prof. GS wrote a personal letter to the Prime Minister in the last week of November 1984 about the readily

available indigenous technology and requested him to reconsider the decision to import the foreign technology. Due to the pressures from the DFG, Vigyan and others for reconsideration of decision taken to import the technology, the government appointed a committee under the Chairmanship of Dr. VR, then Director General of the governmental council for research. Dr. VR visited MECHICO on 13 January 1985. The members of the negotiating committee and Dr. SR from PCL (Petrochem Ltd) was also present. It may be noted that PCL, a public sector company was chosen to execute NSF in their complex using HSC technology. Dr. VR submitted his report in February 1985. Excerpts from his report are given below:

"MECHICO can produce a maximum of 25 TPA and it is estimated that they need to install several facilities to further improve current pilot plant technology so that it can satisfactorily yield high quality material economically and consistently. MECHICO need to establish several additional facilities for analysis and characterisation of silicon and intermediates in a special clean environment. But this would take some time. Such facilities have to be dedicated solely for evaluation of production material. On this basis, provided MECHICO make modifications and improvements outlined, it seems likely that MECHICO would be able to produce large quantities by end 1986 or early 1987.

"A government firm in electronics (GEL) has already offered to purchase all polycrystalline silicon of satisfactory quality from MECHICO.

"The requirement of high purity silicon for GEL is in excess of 150 TPA for production of 6 to 7 MW photovoltaic. There is additional requirement for meeting needs of another company, who will have a capacity of 2.5 MW photovoltaic. The requirement for Electronics may be of the order of 5 TPA. It is expected that there would be further growth in the demands of photovoltaic as these are required for railways, communications, oil platforms, pipelines, border security and defense forces as well as in many remote areas. Dramatic improvement in certain aspects of living conditions are occurring in rural areas by provision of assured electricity for storage of medicines and antibiotics, telecommunications, radio, television reception and lighting in schools for night classes. The demand is bound to grow further very rapidly.

"In view of these demands, it is appropriate to establish a National Silicon Facility with a 200 TPA capacity for pure silicon as early as possible, in addition to the 25 TPA capacity projected by MECHICO.

"In conclusion, I strongly recommend the establishment of the National Silicon Facility with 200 TPA capacity based on HSC technology. In addition, I recommend all support be given to the fuller delineation of technology of MECHICO and assistance and advice offered to them for production on pilot plant of high quality material consistently and economically. They have been given assurances that their production of 25 TPA will be purchased by GEL. Simultaneously I recommend, Department of

Electronics may give support and grants for indigenous R&D for process development and for facilities for analysis and characterisation".

This was accepted by the government. The Government's decision on NSF's polysilicon plant as informed to the parliament (house of states) on March 14, 1985 was as follows:

"The Government have taken the decision to enter into an agreement with the HSC, USA after a careful assessment of the present stage of the techno-economic viability and cost effectiveness of the indigenously developed process. At the same time, the Government will give the fullest support to the effort for the development of indigenous process on a commercial scale, and the investment decision in regard to the National Silicon Facility will be taken <u>only</u> after evaluating the results achieved by the production unit of 25 TPA being set up by the MECHICO".

**4.9.6. Status in 1986**

The Committee for development of materials and electronics met sometime late 1986 to review the situation. DOE had received the process package from HSC on 6 December, 1985. Two installments of the know-how fee covering 35% of total lumpsum fee (10% at the time of taking the agreement on record), amounting to US $ 2,345,000 (Rs.2.93 crores) had been paid. The complete basic engineering package had been received and the next installment of 25% of the lumpsum payment amounting to US $ 1,675,000 (Rs.2.10 crores) was sue in late 1986. Materials

requisition and other engineering details for proprietary equipment have been submitted by HSC to DOE. The manuals for operation, maintenance and testing were being finalised by HSC. These had to be sent to DOE by end October, 1986 but had been slightly delayed. By then no action had been initiated by DOE on work related to setting up of the plant.

The committee further noted that all test reports from abroad with respect to MECHICO silicon are dated earlier than February, 1985, indicating that samples of polysilicon were obtained from the pilot plant in 1984. In June 1986, an electronic company made devices using silicon wafers supplied by MECHICO. Results on suitability were inconclusive and the company had asked more samples for determining overall yield and its repeatability. It would take about one to two months to get results on the evaluation of this material from SPV cell manufacturers.

### 4.9.7. Setting up of METSIL

In the meantime, Director, Vigyan had become the Chairman of Scientific Advisory Committee to the Prime Minister. He brought these developments to the notice of the Prime Minister in 1985 itself. A large number of reports appeared in the popular press, criticising the government's decision to import. A meeting of Prof. VM, Prof. GS and Mr. RVR with an Officer On Special duty (OSD) in Prime Minister's office was held in 1985. The OSD asked them whether MECHICO could produce silicon of international

quality within a year. Prof. VM and MECHICO took steps to produce this in a year. MECHICO set up a separate subsidiary company METSIL in December 1985. The commercial production of polysilicon was started in April, 1986.

**4.9.8. Joint Evaluation Committee**

When METSIL informed in June 1986 that their plant has been operating regularly, a joint evaluation committee of DOE and DFG was constituted. The committee visited METSIL in the first week of July and submitted its report on July 24, 1986.

A major conclusion of the joint evaluation committee of DOE and DFG was that "METSIL had done a very commendable job in having installed, commissioned and operated a plant for high purity silicon in such a short time of less than a year. They have adequate capabilities in the area of process technology, engineering and characterisation. In the context of the proposed National Silicon Facility, involving a production capacity of 200 TPA, the Committee observed that for upscaling of the present METSIL technology to 200 TPA level, the investment is not likely to exceed Rs. 20 crores. This was a total reversal of the earlier assumptions of other Committees and the DOE. It is also noteworthy that apart from the cost of imported technology, the indigenous technology had come of age within one year, whereas HSC wanted 4 years to establish the 200 TPA plant.

On the basis of the evaluation committee report, the Prime Minister ordered termination of the contract with HSC, in October 1986.

#### 4.9.9. Demand Projections

Another reason that weighed the Secretaries Committee in late 1984 to clear the NSF project was the limited capacity available (25 TPA) with the indigenous producer when the country's demand was estimated to be 200 TPA. The estimation proved incorrect. But at that point of time, demand projection of 200 TPA precluded adoption of indigenous technology and led to import of technology.

However, the joint Evaluation Committee appointed by the DOE and DFG had observed (July 1986) that the earlier estimates of demand for silicon needed downward revision in the light of the developments in the field of thin film solar cell technology. The Committee had also recommended adoption of indigenous technology since M/s METSIL was able to produce 25 TPA and the capacity could be easily expanded. Thus, the conclusion of the joint Evaluation Committee was totally different from that of the Secretaries Committee. Since the Secretaries Committee was aware that silicon scenario was fast changing it could have recommended payment of US $ 2,00,000 to keep the options open for future decision as was offered by HSC. Instead, the Secretaries Committee recommended confirmation of the contract and ultimately when the contract was terminated after negotiations, US $2,00,000 was additionally paid to HSC. In other words, the payment was ultimately made without the benefit of future option.

Even with incorrect assessment of demand, it was possible to adopt indigenous technology because the NC had indicated earlier that the production of poly silicon was highly modular and scaling up was dependent upon addition of new reactors. In February 1985, before the agreement with HSC confirmed, the DFG had indicated the possibility of adopting indigenous technology without difficulty. This was considered but not accepted and import of technology was resorted to.

**4.9.10. Cost of Imported Technology**

The Electronic Commission, in January 1984, had observed that on the basis of commercial norms, the cost of production of poly silicon at NSF at 75 per cent installed capacity would be in the neighborhood of Rs.2,600 per kg or more. As against this, the MECHICO cost of production was Rs.850 per kg without the economies of scale, subsidised financing and subsidised electrical power. The international price ranged between Rs.500 and Rs.600 per kg. Thus, the EC had noted the high price at which NSF was being established but supported it.

The high price for the imported technology was also pointed out by the Secretary, DFG in November 1984 itself. He had indicated that NSF with 200 TPA capacity could be established within Rs.21 to 25 crores using Vigyan technology. Yet, establishing NSF with HSC technology, at a total cost of Rs.92 crores was decided upon.

In October 1986, Government ordered that the future development of production facility in the country for poly silicon should be based on indigenous technology and agreement with HSC should be given up in the best possible manner. Till then, the DOE had paid Rs.2.9 crores towards two installments for the know-how and process package.

By April 1987, when the DOE submitted a further note, another installment of Rs.2.15 crores for basic design engineering documentation had become due but remained to be paid and was paid later.

The department stated (October 1987) that the technology agreement was entered into as an insurance for meeting the demands of strategic silicon. This is not tenable since the demand for strategic silicon was miniscule whereas the amount paid to HSC was for 200 TPA plant which was essentially to be used for solar cells application.

Thus, incorrect assessment of demand, partial analysis of potentialities in PV field, non-cognizance of indigenous capability, exercise of wrong option etc. led to conclusion and subsequent termination of a contract with a foreign firm resulting in unfruitful expenditure of Rs.7.92 crores.

## 4.10. SILICON: ANALYSIS

### 4.10.1. Innovation Stages

From an analysis of events starting from the initial investigation in the late 70s to the launching of commercial production in 1986, the development of the silicon technology has gone through various stages of innovation as identified by Pelz. The earlier research experience of the innovator and the earlier innovations which were transferred to the MECHICO determined the choice of the process to be developed. Since MECHICO was already manufacturing Silicon Tetra Chloride (STC), the problem was reduced the development of a process to make high purity silicon from the STC feed stock. The innovation stages of concern, search for existing information and appraisal of various possible approaches had taken place very quickly. The 'design' stage where the innovation is developed together with methods to install it in a production process took a few years. There were laboratory scale experiments at the Vigyan and later pilot plant production at MECHICO Ltd. As has been seen in various cases, activities related to seeking 'commitment' to the innovation started during the pilot plant stage even before the silicon was duly evaluated. Thus stages of design, commitment and implementation overlapped and the events occurred during the commitment function did influence the implementation. These stages also were gone through in a span of 2 years (1984-86).

The overlap of the later innovation functions (design, commitment, and implementation) does not seem to be the result of

the characteristics of the innovation itself. The innovation was original, highly complex which required a high level of skill and a well controlled organisation of the production, and was not demonstratively cost-effective. But the reasons for such overlap in this case is not the above. The innovation had to compete with an imported technology from the HSC of the U.S.A. The champions of this innovation seem to have evolved a strategy to further the prospect of this process. That strategy has determined the activities in the innovation chain and has quickened the pace and introduced overlap.

### 4.10.2. Champions and Alliance of Champions

Prof. VM emerges as one of the champions of Vigyan silicon process. Even after the agreement with HSC was signed in April 1984, he did not keep quite. He worked for the termination of agreement. He made two decisive moves, which resulted in the adoption of Vigyan technology. One was the direct appeal to the Prime Minister in November 1984. The second was the assurance given to the PM's office in 1985 that the commercial production of high quality silicon could start at MECHICO within a year. He exhibited a high risk taking ability and innovativeness in his attempts to influence the highest decision making power in the country.

Mr.RVR, the president of MECHICO was another champion of this innovation. He took a bold step and invested first in the pilot plant and in 1985 in production plan for producing silicon,

when an agreement with HSC had already been concluded. If the agreement had not been rescinded, there was hardly any chance the government companies would buy from METSIL. He took an enormous risk in these decisions. He and Prof. VM together initiated a number of activities to influence a number of persons including press reporters.

Dr. GR at DFG acted as another champion of the innovation. DFG was the only purchaser of solar photovoltaic modules (SPV modules) in the country. As per the estimated demand 95% of silicon to be produced would be required for SPV manufacturer. Thus DFG was in a position to influence the demand for silicon. Dr. GR initiated following activities to strengthen the case of Vigyan silicon. An evaluation group was constituted by DFG just before the agreement with HSC was confirmed. The evaluation group had opted for Vigyan silicon technology thereby increasing the pressure on the DOE to terminate the agreement. The DFG also brought to the notice of the government, in November 1984, the high cost of imported technology when compared to the Vigyan process. The DFG also joined Vigyan and others in requesting for a review of the government decision, which resulted in the appointment of VR committee in January '85. The report of VR committee, though did not favour the termination of agreement with HSC, recommended all assistance to MECHICO. The report made the government to delay the decision regarding actual investment in plant and machinery. By initiating these moves, Dr. GR was promoting inter-departmental conflict between DFG and DOE. DFG was not a direct consumer of silicon. Whichever technology is

chosen, the SPV panels would have been supplied to DFG for which a budgetary provision was made by the government. It is unusual for a government officer to actively promote a technology which calls into question the wisdom of another department. He took some risk in these endeavours.

Was there an alliance between them or were they acting independently? It is very clear from the events that Prof. VM and Mr. RVR were acting in unison. In fact they met the officer on special duty in PM's office together. The way MECHICO and Vigyan initiated various moves clearly indicates that there was an agreement on strategy to be followed among Prof. VM and Mr. RVR. We can conclude that there was an alliance of Prof. VM and Mr. RVR. It is not very clear whether the other champion Dr. GR was also part of such alliance. However the timing of the DFG interventions first when the DFG pointed out that the price of imported technology was quite high (Nov.84), next when the DFG set up an evaluation group to certify the quality of MECHICO silicon (January 85), shows that Mr. GR was implementing the same strategy as adopted by Prof. VM and Mr. RVR. It is likely that Dr. GR was also involved in making and implementing the strategy.

#### 4.10.3. The Strategy to Secure 'Commitment'

We must note that by April 1984, the government had entered into an agreement with HSC of USA. This was rescinded in October 1986. For little over two years, the alliance of champions worked at an objective, which in normal course would have been

impossible. By rescinding the agreement the government stood to loose a lot of money, nearly Rs.80 million. The strategy consisted of two distinct set of activities. One set of activities related to meeting technical objections regarding quality, ability to produce quickly etc., on technical grounds. Samples were sent to various testing laboratories as well as manufacturers of electric devices and SPV panels. On the price front also efforts were made to show the silicon, though costlier than international prices, was cheaper to HSC technology. The other set of activities related to influencing the political decision makers, that too at the highest level. PM himself was approached. The issue was posed as good national technology versus inferior foreign technology. Issues like self reliance, promotion of national endeavours were brought up in numerous press reports. Members of parliament were also influenced to take up the issue, as was evident from the statement made to the house of states by the government. In short, decision making in the government which in normal course follows the organisation process model (after Graham T Allison), was pushed towards a political process. By raising the issue of national self reliance, the problem itself got a new focus.

In doing so, the alliance exhibited remarkable risk-taking abilities. The moves were always initiated by the alliance, making the government react. The alliance was proactive. There were dramatic, innovative leaps forward, when faced with threat. The alliance adopted a strategy that would befit a venture-entrepreneur.

### 4.10.?? Role of Committees

This case shows the role of committees in the decision process. There were (a) task force to choose a process, (b) negotiating committee to choose a collaborator, (c) Electronic Commission to approve the choice of collaborator, (d) a committee of secretaries to give approval to the detailed proposal, (e) the evaluation group of DFG to check the quality of Vigyan silicon, (f) the Varadarajan committee to review the decisions taken earlier, (g) the committee on development of materials in electronics who reviewed the status, and (h) the joint evaluation committee of DOE and DFG. Of these many committees, two changed the course of the process. The Varadarajan committee, though approved the setting up of NSF with collaborating with HSC, it gave some legitimacy to Vigyan-MECHICO efforts by recommending all help to MECHICO to go ahead with its plans. It was sure that the output of MECHICO will be bought by GEL. We must note that Dr. VR was earlier chairman of PCL, which was to set up the NSF. Though NSF would have been a minor area for PCL, which is a giant petrochemical complex, it provided them with an opportunity to enter a field of importance. The VR committee, unlike the task force, did not find MECHICO-Vigyan process inferior to HSC process. It only found MECHICO wanting in the area of quality estimation and control. It did not find MECHICO as competitor to HSC. It recommended a co-existence. There was clearly an attempt to buy peace and make Vigyan-MECHICO agree to the compromise.

The joint evaluation committee was constituted in early 1986 after the PM's office had intervened. The committee was aware of the government's decision (as stated in the house of people) that investment in NSF would be undertaken only after watching the developments at MECHICO. MECHICO was given a year's time to set up and produce consistently high quality silicon on a commercial scale. When this was achieved by April 1986, the joint evaluation committee had very little options before it. It became a body to legitimate the bargain struck between the Vigyan-MECHICO and the PM's office. It recommended adoption of MECHICO Vigyan process, leading to the termination of the agreement with HSC.

Task force which was constituted by the department of electronics to configure NSF was the important committee which decided in favour of import of technology. It rated the Vigyan process as inferior despite protest from Prof. VM. It is strange that the task force did not ask Vigyan to prove their quality. It seems plausible that a decision to impart the technology must have been taken earlier and the task force was merely providing supporting grounds for such decisions. The other committees like the negotiation committee, the electronic committee, the secretaries committee provided further support and legitimacy to the import of technology.

The committees except the VR committee have played the role of legitimising the decisions of either department of electronics or Vigyan-MECHICO combination. The VR committee strived to achieve a compromise.

This case demonstrate that an alliance of champions, evolving and implementing an entrepreneurial strategy has been able to make the government to rescind an agreement at a considerable cost to the exchequer.

# CHAPTER V

# A COMPARATIVE ANALYSIS OF THE CASES

## 5.1. Characteristics of Innovations

### 5.1.1. The kind of users

All the five innovations were developed to fulfill specific needs. Three of the five innovations namely cookstove, gasifier and housing technology products were to meet requirements of individual consumers, whereas the handpump was developed to meet a community need. Silicon was a material to be used by other manufacturers of photovoltaic and electronic devices. Though the nature of the consumers were different, all innovations were disseminated using the finances from government departments/ agencies.

Cookstove, gasifier and silicon represented a fairly new approach in designing and development in comparison to the other two innovations. They did not depend upon earlier designs. They had some degree of originality. On the other hand handpumps and building technology products drew upon the earlier designs and were only novel modifications of them. This process is very explicit in handpumps. Building technology research also adopted the process of modification and adaptation of older concepts.

### 5.1.2. Complexity of innovations

If we define the complexity of an innovation as the degree to which the user requires in-depth training to enable him to understand and use the innovation, the building technology products and gasifier would turn out to be quite complex whereas the handpump, cook stove and silicon would be simple.

Handpumps and gasifiers could be manufactured in small scale industries, with little investment and with skilled mechanics. Building technology components and the cook stove have to be built in situ. This could be done with skilled masons with a set of pre-fabricated components. These pre-fabricated components could be made in small industry. Though the manufacturing methods are simple for these four innovations, they require strict adherence to dimensions and other process parameters. Hence some amount of training of skilled manpower is involved. The training requirements are low for manpower engaged in manufacture of handpumps and gasifiers, whereas the training requirement is higher for masons engaged in stove and building constructions. The process of manufacture of silicon is complex, requires large amount of investment and a tighter control of process of production.

### 5.1.3. Relative advantage

All the five innovations had considerable degree of advantage over the way in which the users were fulfilling the same needs. Cookstove, gasifier and building technologies offered economic benefits?to the users. The handpump reduced the drudgery in water collection and the silicon made the imports unnecessary.

Use of efficient cookstove and handpump reduced the time taken for the same tasks. By removing the smoke from the kitchen the cookstove also reduced health risks. All five thus had a clear relative advantage over the existing technologies. The quantum of such an advantage as perceived by user would differ. Both cook stoves and handpump offered a number of advantages viz., reduction in cost, time, drudgery and health benefits. They needed little or no investment from the user. Gasifier on the other hand provided only an economic advantage but increased the time taken to perform the tasks, maintain and also increased drudgery. The economic advantage was only visible if used for more than 600 hours a year. Building technologies reduced costs but increased the user's effort in procurement of material, supervision and quality control. Silicon did not have an economic advantage for the user. Since it made imports unnecessary, the reliability of supply to the user was assured. Overall we could say that cookstoves and handpumps had a high degree of relative advantage, building technology and gasifier a medium degree and the silicon a lower degree of relative advantage.

### 5.1.4. Compatibility and demonstratability

The silicon was highly compatible with existing practices of the user and so is the case with handpumps. These two did not require any change in user's practice. The cookstove required very little change in the user's practice in tending the fire. Gasifier and housing technologies required considerable changes in the user's practices and user's training was an essential

component of the dissemination programme.

These innovations were demonstrable in the sense that user could clearly observe the relative advantages through demonstration. Cookstove, handpumps and silicon had a very high degree of demonstratability. The results could be observed by the users very clearly. The gasifier's advantage in diesel conservation could be clearly demonstrated, but whether diesel conservation is adequate to warrant an investment could not be clearly demonstrated. The economies depended upon the number of hours of operation, crop type etc. Benefits of housing technology were even more difficult to demonstrate as the number of elements were large. The quantum of economic advantage also depended on the architectural design, the supervision etc. The following table gives a comparative picture among these cases on these parameters.

**Table 5.1: Technology characteristics**

| | Originality | Complexity user | Complexity mfr. | Rel. advantage | Compatibility | Demonstrability |
|---|---|---|---|---|---|---|
| Cookstove | High | Low | Medium | High | High | High |
| Handpump | Low | Low | Low | High | High | High |
| Gasifier | High | High | Low | Low | Low | Medium |
| Building tech. | Medium-Low | High | Medium | Low | Low | Medium |
| Silicon | High | Low | High | Low | High | High |

**5.2. Innovation Stages**

**5.2.1. Overlap among innovation functions**

Pelz had identified 7 innovation functions: concern, search, design, appraisal, commitment, implementation or incorporation and diffusion. (Refer to Section 2.1). We could clearly discern in the case of these five innovations that the functions of design, appraisal, commitment, implementation, incorporation and

diffusion have taken place. In all the cases except the hand pump, activities of concern, search of existing knowledge, and their appraisal, had taken place before funding of the research proposal. In the case of hand pumps they were undertaken as part of the research project itself. We can also notice that functions of appraisal, seeking commitment, and implementation overlapped in time.

### 5.2.2. Appraisal

We had earlier noted (ref Sec.1.4) that there are two kinds of appraisal - one done by the scientist to verify whether his innovation meets his criteria (design appraisal) and other by the adopting organisation. In the case of the cookstove, a detailed design appraisal with respect to compatibility and performance in actual use condition was planned by Prof. RK and SL through a field trial project. Since the commitment activities had been started by Dr. SH and that proceeded at a faster pace this appraisal function was given up. In the case of gasifier the design appraisal activities had started by fabricating a few gasifiers. However activities of seeking commitment and implementation which were started simultaneously rendered a detailed design appraisal unnecessary. But in the cases of housing technologies and handpump activities of seeking commitment and implementation/incorporation took sufficiently longer time. Hence extensive design appraisal of the designs through field trials could be undertaken. In the case of silicon pilot plant trails and testing of quality were undertaken while

activity of seeking commitment went on. We can conclude that in these innovations the functions of design appraisal and commitment were initiated together. The appraising activities by the scientist were terminated if commitment could be secured earlier. Thus appraisal was undertaken in order to provide support to the activity of seeking commitment, and not to provide feedback to the designer for modification of the design.

We may also note adopting organisations like DFG (Cookstove, gasifier and silicon) had their own process of appraising the innovation. These adoption appraisals were essentially performed by committees constituted for this purpose. These committees either did not use a pre-fixed criteria or had a criteria so lenient, as in the case of stoves and gasifier, almost all competing innovations could pass this stage. Thus appraisal either done by the scientist or by the adopting organisation was not an important function.

### 5.2.3. Incorporation

Another point to note is that there were no distinction between activities of implementation and incorporation. Pelz defines implementation as the activity of application of innovation in order to evaluate it or modify it, and incorporation as an activity by which the innovation is accepted as a standard practice with a claim on resources. In his study of urban innovations also, Pelz did not notice such fine distinction

and clubbed these functions together for his analysis. Only in case of gasifiers there were attempts to improve the innovation in fifty locations before incorporation. Even that was given up. The five innovations we have studied demanded governmental financial support for dissemination. Incorporation was done so quickly by the concerned government departments after commitment was achieved, diffusion followed.

### 5.2.4. Sequencing of innovation functions

We can also identify a clear sequence of functions. Functions of concern and search preceded function of design. Appraisal and commitment were taken up together after design. Incorporation / implementation and diffusion took place after commitment. In time scale there were thus four stages: (i) concern and search, (ii) design, (iii) appraisal and commitment and (iv) incorporation/implementation and diffusion. The following table gives the time schedule of these innovations.

**Table 5.2: Innovation Stages**

| | Cook-stove | Handpump at Vigyan | Handpump at RAC | Gasi-fier | Housing tech. | Silicon |
|---|---|---|---|---|---|---|
| Concern and search | Before start | One Yr. | Few months | Before start | Before start | Before start |
| Design | Two Yrs. | One and half Yr. | One Yr. | Four Yrs. | Three Yrs. | Three Yrs. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Appraisal & commitment | Six months | Two Yrs. | Two Yrs. | Eight months | Four Yrs. | Two Yrs. |
| Implementation(a) | Three months | (b) | Six months | Six months | < One Yr. | Six months |

(a): Time taken under implementation/incorporation indicates the time taken by the respective government department to plan, to secure a budget and to institutionalise an ongoing mechanism for dissemination. This is done after the decision to promote the technology is taken at the end of the commitment function. In case of silicon, it refers to the time taken to formally annul the HSL deal after the report of joint evaluation committee.

(b): In the handpump (Vigyan) case there was no implementation/ incorporation as the functions of seeking commitment could not be concluded successfully.

A look at Table 5.1 and Table 5.2 indicate that there may be relationship between originality and the time taken for design. Innovations with high originality have on an average taken more time to design.

Table 5.3: Relationship between innovation characteristics and time for completion

| Innovation | Originality | Time taken for design | Relative advantage | Compatibility | Demonstrability | Time for appraisal commitment |
|---|---|---|---|---|---|---|
| Cookstove | High | Two Yrs. | High | High | High | Six months |
| Handpumps (RAC) | Low | One Yrs. | High | High | High | Two Yrs. |
| Gasifier | High | Four Yrs. | Low | Low | Medium | Eight months |
| Building Tech. | Medium-Low | Three Yrs. | Low | Low | Medium | Four Yrs. |
| Silicon | High | Three Yrs. | Low | High | High | Two Yrs. |

On the other hand this small data set reveals that characteristics such as relative advantage, compatibility and demonstrability have had no influence on time taken for appraisal and commitment functions. This is counter intuitive and needs to be explored in further research. Another point to be noted is the very early start of the functions of seeking commitment concurrently with appraisal. As has been stated earlier in Sec.5.2.2., appraisal was not an important function. Decisions of commitment were made without or only with partial appraisal results.

In conclusion we can state that all the five innovations studied here had proceeded in clearly identifiable sequence of innovation functions. There were some overlap among later innovation functions. As has been the experience of other researchers, the time taken for the completion of the process

could not be explained purely based on innovation characteristics.

## 5.3. Champions and Alliances

Table 5.4 below gives the names of champions, their affiliation and the time of entry.

**Table 5.4: Champions and time of entry**

| Innovation | Names of champion | Affiliation | Time of entry |
|---|---|---|---|
| Cookstove | SH | Scientist (non-innovator) | After 'design' |
| | VB | Administrator from provincial government | After limited field trial by SH |
| Handpump | KS | Engineer (RAC) | Right from the beginning |
| | RT | UNF | During the 'design' |
| Gasifier | SM | Scientist (Vigyan) | During 'design' |
| | KS | Administrator (DFG) | During 'commitment' stage |
| Housing technology | SJ | Scientist (Vigyan) | Right from the beginning |
| | VS | Administrator (HOUSECO) | During Commitment stage |
| | AJ | Administrator (CORT) | During Commitment stage |
| Silicon | VM | Scientist (Vigyan) | Right from the beginning |
| | VR | Industrialist | Right from the beginning |
| | GR (DFG) | Administrator | During commitment stage |

All the five innovations had an innovation champion from the scientific/technical community. Except in the case of cookstove, where a non-innovator scientist championed the cause, all other four innovations were actively promoted by one of the innovators. In the case of gasifiers Dr.U.S., the original initiator of the work gave way to his colleague Prof. SM to champion the cause. The R&D funding organisation did not play the role of innovation champion. In all innovations, championing of innovations started even before a full appraisal/field trial could be undertaken.

In all cases efforts of the scientist-innovation champion was not enough to influence the decision process at the adopting organisation. When the efforts were made only by the scientist, the decision process was progressing slowly with interrupts and cycling. This could be evidently seen in the housing technology where there were attempts by Prof. SJ for well over 4 years with different departments, to disseminate the technologies. These resulted basically in requests for more demonstration, training and standardisation. No decisions were taken regarding acceptance of the technology and incorporation of it in the regular programme. Similar process could be seen in the case of handpump (Vigyan) and gasifier (prior to Sept 1986). The causes for this slow pace of activities concerned with commitment seeking can be explained by the strategy adopted by the scientist-champion. (Please refer to Section 5.4). As has been shown in all cases, the decision process at the adopted organisations was influenced and a decision for implementation was taken due to the initiative

of a person in the implementing/financing organisation working in alliance with the scientist. There has been an active innovation champion from the disseminating/financing organisation in every case. Mr. RT (handpump), Mr. VS and Mr. AJ (housing), Mr. KS (Gasifier), Dr.GR (Silicon) played significant roles in alliance formation, the strategy formulation and its implementation. Only in the case of cook stove the other champion (Mr. VB) was not from the implementing/financing organisation. But since he was from the administrative services and was Secretary to the CM, he could influence the implementing/financing organisation.

In all cases alliances were formed due to the initiative of those administrators who acted as innovation champions. The causes that led to these persons taking upon the role of innovation champion must be explored. They could have allowed the process to go on in the same pace and awaited the outcome of adoption appraisal etc. A look at the cases indicate that they were fulfilling certain other objectives using these innovations. They were attempting to enhance the image of their organisations and themselves by promoting the innovations. They had a reputation to preserve or build upon. For instance in the housing case, Houseco was moving from a mere housing finance organisation to an organisation concerned with all aspects of shelter including technology. In the case of cookstove, gasifier and silicon, the DFG which had been set up in 1982 to promote renewable energy, positioned itself as promoter of new innovations in renewable energy and promoters of self reliance in this field. The UNF was not a mere funding organisation. It

wanted to promote efficiency among organisations responsible for providing succour to the poor. Hence UNF was organising training programmes, promoting new technology in the area of deep well handpumps.

Because issues like image, efficacy, reputation etc., were involved, they always choose an innovation/scientist from an organisation with high credibility. In cases where there were choices possible (stove, gasifier, housing), these innovation champions chose innovations from the Vigyan, an organisation with high image/credibility. This alliance was used to legitimise their activities within their organisations. Even in the handpump case, there were repeated attempts by UNF to form an alliance between Vigyan and RAC, which did not materialise.

The alliance so formed achieved two objectives. The innovation got incorporated, implemented and the objective of enhancing the image and fulfilling of its mission of the adopting organisation was also fulfilled. The funding organisation and the innovators had complementary objectives which got fulfilled by adoption of innovations.

## 5.4. The Strategy of Champions

### 5.4.1. Strategy of innovator-champions

In the cases of handpump (Vigyan), housing technologies and gasifier, innovator-champions attempted to disseminate their innovation by adopting a strategy. From their activities it was clear that they believed that innovation characteristics alone

influence innovation adoption behaviour. They also believed that adopting organisations to a large extent decide on the basis of costs and benefits analysis. Hence demonstration of their innovation was considered a crucial element in the dissemination. Another important element in their strategy in four of these cases was the close links to their sponsors, CST which is a provincial level organisation. They expected CST to help demonstrating their innovations to provincial level implementing organisations. They initiated the moves for dissemination. But their subsequent moves were responses to the acts of provincial level implementing organisations. They adopted a satisficing approach. They did not approach the federal level organisations who plan and fund programmes to be executed by the provincial level organisations.

The CST was financially a small organisation which could not have given all the resources required for diffusion. The provincial level implementing organisations on the other hand depended on federal agencies for technical advice, training and funds. They would not risk initiating adoption of new innovations, <u>outside</u> the technologies in force, without first being adopted by the federal agencies. The strategy of innovators resulted in <u>almost</u> a cul-de-sac, from which the innovations were rescued by the administrator-champions.

Only one innovator-champion Prof. SJ (housing technologies) attempted a dissemination outside this path. He was establishing contacts with non-governmental organisation (NGOs) in various

provinces and tried to disseminate his technology. Once again NGOs were financially weak and looked towards their donors for project support. The dissemination was very very slow.

The innovator-champions did not evolve a full dissemination strategy. Dissemination of an innovation requires technology transfer to manufacturers, financing both manufacturing and purchase, training both manufacturer and user, quality assurance, market development and other activities. A number of inter organisational relationship had to be established, which would eventually form a network of stake holders. Scientists are not generally enamoured at these tasks. They expected the government agency to structure such a network.

**5.4.2. Strategy of alliance of champions**

On the other hand the strategy adopted by alliances of champions in all 5 cases have been evolved in the entrepreneurial mode. The salient features of such entrepreneurial strategy were (a) pro-active nature of activities, (b) high risk taking ability, (c) imaginative and innovative leaps in the face of barriers and uncertainty, (d) the dissemination as the single goal.

All the cases clearly show that once an alliance between administrator champion and scientist champion had been formed, the activities were initiated by the alliance at all times and the implementing-adopting agencies were made to react. A highly proactive stance was taken.

By pushing a dissemination programme of large magnitude of innovations which have not been extensively field tested or appraised, the alliance was taking very high risks. There are instances in every case to support this. For example, Prof. VM and Mr. VR took a great risk in accepting to set up commercial production of silicon within a year.

Barriers to technology and uncertainty were tackled with some imaginative moves. They included changing the focus of innovation as in gasifier, changing the target market segment as in housing technologies, implicating issues other than mere technology choice as in silicon. The goal also shifted from mere demonstration of good technology to an active dissemination.

We could discern some common elements in the strategy of the alliances across all cases. The alliance and especially the administrator-champions understood the organisational processes of adopting/implementing organisations. These organisations used the advisory committees or standardisation committees to (a) bestow legitimacy to their progammes and (b) help the organisation in making choices. Influencing these committees became an important task for the alliance. This was done by making the innovator-champion a member of these committees. This could be seen in the cases of hand pump, housing technologies and gasifier. In the case of silicon where this was not done, attempts were made to influence the important committees like the VR committee and the joint evaluation committee.

The second element in the strategy of the alliance was to increase the pressure on adopting organisations to step up the pace of the decision-making. This was done by implicating other issues along with technology choice. It was the provincial autonomy in the case of cook stove, the self reliance in the case of silicon, the achievement of targets in case of gasifier, the image of houseco in the case of housing and promotion of standardisation in the case of handpumps.

The third element was modification in the technology package or a change in the market segment, if suggested by adopting organisation or their committees. Such modifications were accepted if that was the only way in which the process will move on. Attempts were made to keep such changes of focus to the minimum. For instance in the hand pump case, RAC accepted NSO's first draft on standards which included a number of suggestions from Vigyan. But subsequently,they convinced the NSO committee to drop a number of them at the time of revision of draft.

The fourth element was that the alliance structured the entire dissemination programme for the adopting organisations. Manufacturers, field implementors, trainers, quality controllers and others were identified and necessary inter-organisational relationships established. These relationships developed into a network in 3 cases (cook stove, gasifier and handpump). This increased the number of stake holders in the innovation. This also ensured that all functions required for dissemination will be performed in a coordinated manner.

### 5.5. Decision Process

Decisions in these cases were made at (a) research and development funding organisations, (b) by champions and (c) adopting implementing organisation both at federal level and at provincial level. The research sponsoring organisations well as adopting organisations were governmental or quasi governmental. If we adopt Allison's framework of models of decision making, they have followed essentially organisational process model. The process was characterised in all cases by (a) use of committees, (b) avoidance of uncertainties, (c) choice of least resistant path, and (d) satisfaction of simple acceptable performance criteria. In these processes the pace of decision making is dictated either by load on the system or by the persons involved in the process. The cases highlight that research funding decisions in all cases were predominantly outputs of the organisation process which used a set of a priori selection rules. This could be seen in the proceedings of the Executive Committee of the CST in four cases.

Two of the cases namely cookstoves and silicon indicate that governmental organisations which normally follow an organisational process (after Allison) could be pushed to make decisions under a bureaucratic political mode of decision making. This, as the cases show, is done by (a) implicating other politically sensitive issues like autonomy of provinces in case of stove and self reliance in case of silicon, and (b) increasing threats in the environment through adverse press reports or lobbying with members of legislature or political decision

makers. Organisations tend to follow a particular decision process based on time pressure, uncertainty, threats and perception about costs and benefits. The cases have shown that when champions feel that they may not succeed when the organisational process, based on programmes, repertories and satisficing behaviour is undertaken by the adopting organisation, the champions tend to increase the threat from the environment and implicate other issues to push the process to a political process in which time, people and political power distribution matter. This seems to be the last resort, as the risk of loosing in such a process is also quite high.

**5.6. Interorganisational Network**

If an innovation had to succeed, it must be produced by a manufacturer, marketed and the user need to be trained. In governmental programmes the finances required for these activities were partially provided out of the governmental funds. It is essential to locate and tie up with organisations to manufacture, to market, to provide after sales service and to train the users. The manufacturer may also require considerable amount of training. We can discern a pattern among the four cases, namely handpump, housing, stove and gasifier, in establishing links between these organisations so that they work in a coordinated manner in disseminating the technology. The pattern as we see in the cases shows that the alliance of champions initiate activities related to locating and finalising an agreement with these organisations. Links with the

manufacturers are initiated by the innovator/ scientist champion. For example it was Prof. SM who linked up MMF (gasifier), Mr. KS of RAC with a number of small firms (handpumps), Prof. SJ with a firm to produce 'Vigram' (housing technology) and Prof. VM with Mechico (Silicon). Only in the case of cookstove a number of manufacturers of prefabricated components were identified by the implementing agency, the DRDS. It could be so due to the simplicity of the prefabricated components, which could be produced almost in any small town by a sheet metal workshop. Linking up with field implementing agency and through them with users was done by the administrator champion in all cases, except the case of silicon. In the case of silicon, due to the monopoly of Metsil, the users (photovoltaic cell manufacturers) who themselves were few, could be directly linked up by the Metsil Corporation. Identifying organisations for quality control of the manufacture, installation and organisations for training the user was also done by the administrator champion. Training of manufacturers and in some cases the training of instructors who would train the user was also undertaken by the innovator champion and his colleagues.

Relationships between innovator as a node and manufacturers, and instructors were established. Similarly relationship between administrator champion or his organisation and implementing agencies, quality control agencies and training agencies were established. These two distinct sets of relationships were then inter connected by the alliance of champions using the federal level adopting and implementing organisation as the common link

pin or node. This process then resulted in a network. Activities of the members were controlled by a number of bilateral agreements. Admission of new members into the network was done by the federal implementing agency or in the case of handpump an international funding organisation. Disputes if any were to be settled, by bilateral negotiations using the agreements as the basis. In case this could not achieve results, the network coordinator, normally the federal implementing agency was approached. Only in one case, a formal network (GASMACC in the case of gasifier) was constituted. In other 2 cases (handpump, Stove), the networks were informal, with no written down procedures. In case of housing technology there was no single network. For each market segment a separate inter organisational relationship was established. For the private, urban, middle class market, the housing bank, DRT at Vigyan and CST were brought together to provide training to architects and engineers. We could consider these as simple networks with 3 nodes, the financier, the technology provider and the user. We must also notice that the technology to be promoted by these networks in the housing technology case was not necessarily have to be from Vigyan. The user was given a chance to choose from Vigyan, NBO or Alternative Development. In all other cases the technology choice was not given to user. Secondly in the case of housing there was no single programme, planned and financed by a single federal agency. Financing of this dissemination came from a number of sources.

In the case of silicon also there was no need to establish a

network. A technology transfer from Vigyan to Mechico was sufficient. The user, in this case, manufacturers of solar PV cells and electric devices had no choice but to buy from a monopoly supplier. Functions like quality control and client service was performed by the Mechico.

Hence networks were established in cases where (a) the programme had to be planned and funded by a single agency, (b) where there were a number of organisations to perform a number of tasks, and (c) coordination among them was necessary.

**5.7. Role of Committees**

We note that in all cases, committees have played a crucial role in furthering the innovations. Committees such as the Executive Committee of the CST have decided on issues related to funding of development. In the cases of handpumps, gasifier and housing technologies, there had been requests for time extensions and budget increases. We can identify two significant traits of research funding committees. One is that they would like to promote, if their budget permitted, development without much critical examination of the proposal or its possible future developments. For example, the CST which funded cook stoves, handpump, gasifier and housing technology never based the decision to fund these projects on any analysis of existing innovations, or likely impacts on cost and benefits. For example, there was a fear that large scale dissemination of gasifiers may adversely affect the wood resources of the state. Even without

discussing such implications in detail, the proposals were accepted. The second trait is that they would strive to minimise dissent among themselves and promote consensus. The decisions of the committees finally were always unanimous. Any serious dissent meant a request to modify the proposal.

The cases also show similar tendencies among committees constituted by innovation adoption organisations. They were essentially constituted to help the adopting organisations in choosing innovations to adopt and to formulate a programme of dissemination. Such committees played significant roles in the cases of housing technologies, gasifier and silicon. No formal committees were constituted in the case of cook stove. But a procedure for adoption of a design in the national programme was evolved. In the case of handpump, the adopting organisation UNF and CPHED sought the help of NSO in evolving a standard.

We must note that in all cases there were more than one innovation available for dissemination. The committees were so constituted as to give representation to a number of innovating groups if not to all the groups. We have also seen that innovation champions invariably become members of these committees. We notice that the committees evolved technology choice criteria in such a way that most of the innovations could pass them. For example, 60% diesel replacement was fixed as the criteria for selection of gasifiers. Similarly efficiency of the cook stove for inclusion in the national programme was also fixed at a low value. The NSO committee included features of handpump

designs at Vigyan as well as RAC. Similarly in the case of housing, the committee enabled the user to adopt Vigyan or alternative development or NBO designs. By adopting this attitude, these committees not only preserved their own cohesion but also minimised the chances of serious conflicts among innovating groups. This helped the alliance of champions in their mission as the final choice of technology to be disseminated was left to either the federal adopting organisation or to the provincial field level implementing organisations. A serious appraisal of alternatives by these committees could have put some obstacles in the path of the alliance of champions.

Uncritical promotion of innovations and avoidance of dissent seems to be the guidelines governing the functions of committees.

**5.8. Changes in Innovations**

As the innovation proceeds from one stage to another, it comes in contact with organisations other than the innovating group. Adopting organisations, manufacturers, users and financiers come in contact with the innovation and innovators. These contacts are brought about and mediated by champions, as can be seen from all cases. The reaction by these organisations to the innovation have included certain suggestions for changes either in the innovation characteristics or its user segment or its focus. For example the innovators of cook stove 'Hosa ole' were requested to reduce the cost of the stove by altering some design features. The provincial PHED field testing Vigyan handpump had offered some suggestions. In the case of gasifier

the targeted user segment was changed from retrofitting existing diesel engines to supply of new complete systems. In the case of housing technology the user segment was enlarged to include urban dwellings also. We have also seen the focus of the innovations getting changed as it goes through the stages. In the case of handpumps, the focus got shifted from improvement of existing designs to standardisation of a single design. In the case of housing technologies, the user segment got enlarged to include urban application. At the beginning of the project, the innovating group in housing had a much wider focus - use of soil in all forms, alternate cement, roofing techniques etc. It got narrowed down to compressed soil blocks and panel roofs. The other uses of soil such as rammed earth construction and the alternative cement got left out. In the case of gasifier, the project started aiming at use of wood to replace diesel in existing diesel pumpsets. The scope got widened to include other biomass as well as petrol engines. Further on, after the review committee meeting the scope got narrowed back to wood as fuel in diesel engines.

The reactions to such suggestion for changes in the innovation seems to have depended on two important criteria. Whenever the suggestion for changes were related to the technical characteristics such as design features, there have been opposition from the innovating group. It seems that innovators have fixed and used some criteria to evaluate their innovations before attempting to disseminate; criteria such as efficiency of

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stoves or minimum change in the existing manufacturing process in the case of handpumps. Any suggestions that calls for a reappraisal of their own norms were resisted.

On the other hand suggestions for changes in the user segment or focus of the innovation were linked to dissemination. Since the dissemination was being implemented by an alliance of champions using an entrepreneurial strategy, such changes were accepted as they reduced the barriers to the innovations.

### 5.9. Multi Locational Development

All cases show that a number of innovating groups have been simultaneously attempting innovations in the same area. Both Vigyan and RAC worked on the handpumps. Vigyan, PRI and some other groups developed cook stoves. There were atleast 3 groups working on low cost housing technologies and 7 on gasifiers. Only in the case of silicon there was only one group within the country.

These groups were funded by different funding organisations. Sometimes, as in the case of gasifiers, same funding organisation sponsors research in number of institutions. The cases show that the innovators were in contact by participating in conferences or collaborating in committees. But bilateral relationships did not exist, nor were there any communication sharing their research results bilaterally. The funding organisations also did not interact with each other. This gave raise to a number of innovations with varying performances seeking commitment from

adopting organisations.

The task of choice of technology was performed by adopting organisation using committees as mentioned earlier. Uncoordinated multi location development, thus puts a strain on technology adoption systems, as methodologies of critical technology assessment are rarely followed.

Another issue that emerges is the role of research sponsoring organisation. There have been a number of them. They have also not communicated with each other before initiating their own funding programme. It should also be noted that no champions emerged from these research funding organisations. Such multi locational development and multi sponsoring agencies give room to a situation wherein an inferior technology may get adopted purely due to an existence of good alliance of champions for it. As has been seen, mechanism such as review committees cannot stop such a thing from happening.

This comparative study of cases showed that the alliance of champions and their strategy determine the course of innovation adoption.

## 5.10. A Summary

The comparative analysis of the cases establish that innovations in multiorganisational settings proceeds in clearly identifiable stages. The innovation characteristics, alone, were not sufficient to explain the success of the process.

The cases also show that an alliance of champions, an alliance between scientist and administrators are essential for incorporation of innovation into the government programme. These alliances fashion out an entrepreneurial strategy to promote the cause of innovation. This strategy was able to influence the decision processes in adopting organisation and in cases of stoves and silicon shift the process to a bureaucratic political mode.

Since the innovation process takes place in a number of organisations and the diffusion of innovation requires a number of organisations, an inter-organisation network is essential. This network is created by the champions.

Though a number of committees were involved in the decision processes at each stage of the innovation, they essentially strived to minimise dissent among developers of innovations and fixed standards in such a way, almost all competing innovations could target for eventual adoption.

The champion kept the scope of the innovation flexible and accommodated changes to further its progress.

# CHAPTER VI

# CONCLUSIONS AND DISCUSSION

## 6.1. Stages of Innovations

### 6.1.1. Development stage

All innovations in this study have proceeded in phases. Three phases could be noticed very clearly. They are (i) Development, (ii) Adoption and (iii) Implementation.

It is not possible to explain the time taken for completion of each stage only on the basis of innovation characteristics. Completion upto the design function is dependent on the assessment of the extent of fulfilling certain technical goals. The innovator has to satisfy himself that this stage has been completed. A factor which influences this decision is the quantum of funding available to carry out the 'design' function. Most of the innovations had been funded by agencies other than the organisation to which the innovator belonged. The research funding agency normally prescribes some time and money limits for the project. Though a funding agency takes into account the characteristics of the innovation, while deciding on the matters, other factors do influence their decision. We could from the cases mentioned in this study notice repeated requests for time extensions and budget enhancements. Though the funding agency seem to have been liberal in granting these requests, it had also conveyed its desire to quicken the process.

### 6.1.2. The adoption stage

The process of adoption involved both the innovator and

adopting organisation. It included an element of appraisal. Organisations in the government have followed decision processes that are fashioned by internal organisation processes and programs. Ettlie and Vellanga had shown the impact of interaction between innovation characteristics and the organisational features, in explaining time lag between stages in the adoption process (Ettlie, 1979).

The cases analysed in this study have shown that the adopting government departments have used an 'organisational process' model (after Graham T Allison) in dealing with the adoption decision. In two cases the activities of the champions, pushed the organisation to shift the processing of adopting decision to a bureaucratic political mode. Time taken for making a decision under such organisatonal processes, depend mostly on the load of the system and the criteria defining acceptable performance. The pace quickens only when any further delay would violtate the criteria of acceptable performance.

Since all the innovations studied here are not de-novo innovations, and are improvements or substitutions for existing practices, the characteristics of the innovations did not play a major role in determining the time taken for the adoption process. Rather, the committment seeking activities initiated by the champions and their strategy moulded this process.

In our cases the innovators allied with a champion from the adopting disseminating organisation. Committment seeking became more important function for championing than design appraisal. This may be so due to the fact that all innovations required

incorporation into government programmes for successful diffusion. The innovator-champions in their interaction with government departments might have realised that incorporation into government programs does not solely depend on a rational appraisal of the innovation with respect to its claims. Hence appraisal was designed an??executed only to feed the information requirement of the decision process in the government.

We must note that in all cases, the alliances of champions adopted an entrepreneurial strategy to gain committment and to disseminate the innovation. The elements of the strategy dictated the course of the adoption. We can conclude that the strategy of champions and the organisational decision processes influences the course of the innovation. This confirms our hypothesis, that is when innovations are of incremental nature, the organisational processes of resource and support mobilisation for the innovation determines the time taken for the innovation, than the innovation characteristics.

### 6.2. Champions and Alliance of Champions

#### 6.2.1. Champions

This study has shown, as other studies, that champions are crucial for the dissemination of innovations. The champions play significant role in, technical innovation, affecting flow of information, and training and assisting users. (Robertson 1972 and Howell 1990). Studies such as SAPPHO had identified more than one champion for an innovation. Our study goes beyond merely stating that champions are essential. The study has shown that it

is also essential to have a champion from the adopting organisation especially when the innovation has to be disseminated under government programmes. This study has brought into focus the role of alliance among champions. A common strategy for promoting the innovation is necessary for success of the innovation.

A major point to note in these five cases is that the sponsors of R&D did not play a role of innovation champions. This is true in most advanced countries. But in developing countries like India R&D funding organisations, which are in general government agencies, are expected to play a major role in utilisation of research results. This has not happened. Four of the five innovations mentioned here, were funded by a single, provincial level, Council. Its main objective was to promote application of S&T in the developmental process of the province. The cases show that in these four cases (gasifier, stove, handpump, building technologies) the Council played a role of an ally of the innovation champion. This can be explained. In dissemination of these new technologies, in the initial stages, transfer of knowledge across organisations became crucial. The knowledge resided in scientists innovators. In addition, the Council did not control much larger fund flows to implementing organisations. Having little control over knowledge or funds, the Council could only play a role of an ally to the individuals possessing control over these.

We can see some parallels between internal corporate ventures and innovations. ( Refer to section 2.4 for a discussion

on championing in ICVs.) The laboratories where innovation originates is akin to the operation level of a major corporation. The scientist champion is indeed an operational manager, engaged in strategic forcing activities. We have seen that these champions ally with middle level managers of adopting organisations and create in the initial stages of adoption, demonstration programmes and field trials. This is similar to the evolution of arena strategy. we have also seen that changes do take place in the nature and packaging of innovations due to learning that take place. The cases have shown how different organisations interact and learn from the experiences while building the strategy for diffusion.

**6.2.2. Alliance of champions**

These cases have shown that alliances of champions, one scientist and another administrator. became essential for success. We have also seen moves to form alliances always came from administrators and not from scientists. This raises the issue of why should an officer in a disseminating organisation become an innovation champion. We must keep in mind that the disseminating organisations in these cases, were government or quasi-government bureaucracies. The reward systems in bureaucracies do not provide for individual excellence. In fact bureaucracies tend to make an individual faceless. Coupled to this, in Indian situations, the average tenure of any officer in a particular position is short, less than 3 years. Hence there is a quest among, at least a fraction of, bureaucrats to create their own identity through essentially working as an entrepreneur

within the system and to attempt introducing novel, new processes, techniques and systems. This drive to create a niche for themselves, make this fraction of the bureaucrat to look for opportunities and hence clasping of the hand of an innovator.

## 6.3. Strategy of the alliance

This study has shown that an entrepreneurial strategy seems to be more successful than an adaptive strategy. It has been shown that scientist-innovation champion when acting alone uses an adaptive strategy, which is reactive to the stimuli from the adopting organisation. The alliance however uses an entrepreneurial strategy which is proactive and makes the adopting organisation respond to stimuli from the champions. The strategy consists essentially of three elements: (a) gaining legitimacy for the work of champions, (b) increasing the number of stake holders and (c) implicating other issues. Barriers to the innovations are tackled either with a change in the characteristics or focus of the innovation or by pushing the d??decision process to a bureaucratic politics model of decision making.

We have seen from the cases, that an entrepreneurial strategy was successful and such a strategy could be instituted only after the alliance was formed. The cases had also shown that the scientists-innovators when acting alone had used strategy made in adoptive mode. What would have happened, if the innovator champion while acting alone had adopted an entrepreneurial strategy? Would the alliance be still necessary?

Organisations in the government adopt normal organisational

process (after Allison), which involves standard procedures, committees and satisficing, incremental behaviour. A champion from inside the organisation then has a greater chance of influencing these organisational processes. In government programmes then, the adoption process is greatly facilitated if there is a champion from inside the adopting organisation.

Our hypothesis that champions operating with an entrepreneurial strategy are necessary for an innovation to succeed has been shown to be valid. In fact, the hypothesis could be made more specific by stating that an alliance of champions, with at least one champion from inside of an adopting organisation, has far more chances of success.

### 6.4. Decision Processes

#### 6.4.1. Development funding decision

Decisions regarding research funding for development of these innovations have followed a simple satisficing process with a limited apriori decision rules. We may note that four out of the five innovations received research funding support from a single sponsor. In the case of handpump one more innovation group (RAC) was funded from the internal resources of the company. In the case of silicon, research funding came from a manufacturing company (Mechico) and from a central government department. We may also note that these innovations had less uncertainty and low risk. Even if the research attempt had failed, they were not going to upset the finances of R&D sponsors. The sponsoring organisation had a R&D budget provided by the government, and returns from R&D ventures is not a major factor determining R&D

programme. Secondly these innovations had a high probability of successful technical development as they primarily attempted to build on the knowledge already available. Cookstoves, handpumps, gasifiers and building technologies had a past history. Under these circumstances it is quite natural that a simple satisficing process was used. R&D funding decisions in government or government funded organisations are taken using a simple satisficing approach. Anna Grandori (1984) has formulated a hypothesis that organisations choose different decision processes based on the levels of uncertainty and conflicts of interest. It has been postulated that where these two factors are low a computational rule (satisficing a pre-set criteria) of choice is used. We may hence conclude that research funding decisions in governmental agencies are generally taken using a simple satisficing decision process.

**6.4.2. Adoption Decision**

<u>6.4.2.1. Decision process before the alliance:</u> Decisions regarding adoption of an innovation can be seen in all these cases as an outcome of a process spanning a few months (cookstoves) to a few years (housing). These decisions were made in organisations financing dissemination. They were departments of federal government in three cases (cook stoves, gasifiers, silicon), federal or international funding agencies in other two cases (building technologies handpumps).

The nature of decision process in adopting organisation were transformed by the activity of the alliance of champions. Only in three cases we have some details regarding the process followed

by these Organisations before the alliance could set in motion a number of steps to change the pace of decision process. In the case of gasifier, we have details of decision process before an alliance between Prof.SM and Mr.KS could be established. We also have some details regarding decision process in department of electronics leading to award of contract to HSC before the alliance of Prof.VM, Dr.GR and Mr. VR could increase the pressure. We also have some details regarding approval of stoves in the DFG. We have no details regarding the decision process in Houseco or in CPHED prior to formation of alliances of champions.

The analysis of the adoption process prior to the entry of the alliance shows that the adopting organisations used an 'organisational process model' of decision making. This is characterised by (a) use of standard operating procedures like appointment of committees, (b) uncertainty avoidance, (c) search within the neighborhood. The goals were to satisfy a minimum acceptable performance. The desire to arrive at a consensus and avoid conflicts resulted in standards that enabled almost all competing innovations pass the criteria.

6.4.2.2. The alliance of champions and the decision process: Entry of an active alliance in the decision process changed the pace of the process which , if obstacle persisted, moved to a political process model. The study has shown that if barriers to the innovations could not be tackled in the normal organisation process mode of decision making,the alliance of champions takes substantial risks and pushes the process to a bureaucratic political mode. This was shown in the cases of silicon and

stoves. The process became quick in pace, constricted with fewer participants, narrowly channeled. As it happens in any political process, the nature of problem itself is changed. The objective then was not so much concerned about choosing an innovation but deciding on certain other issues. The problem was transformed and posed in different terms. For instance the issue of self reliance was raised in the case of silicon. We must keep in mind that the process takes place in a bureaucratic environment and there are deadlines, committment for action ('something must be done') which affects the load on the decision making. There is also the requirement of legitimacy and accountability.

In other cases, by quickening the pace of the organisational process, the alliance was able to get the desired outcome.

The alliance of champions influenced the adoption decision process,by increasing the pace of the process and by tackling the barriers in an innovative way.

**6.4.3. Adoption process in provincial organisations**

Agencies responsible for field implementation in provinces rarely took decisions regarding choice of technologies. This needs some explanation. Attempts were made by innovators in case of hand pumps and building technologies to seek adoption in provincial implementing departments, Public Health Engineering department in the handpump case and agencies like Housing Board, district administration in the building technology case. Though these organisations could have adopted the innovations they did not exercise it. In the Indian governmental administration, the

organisation which has the responsibility to provide finances also prepares guidelines for implementation. The implementing Organisations are expected to adhere to them and any deviation, found necessary, is generally scrutinised and approved apriori by the funding organisation.

Secondly there is a close, non formal, relationship between personnel in the federal financing/planning organisation and the provincial implementing organisation. They are built over training programmes, meetings of committees and visits. These prior relationships also have an effect on the decision process of implementing organisations. Uncertainty avoidance coupled with the prior relationship between a funding organisation and the implementing organisation makes the implementing organisation generally unwilling to initiate new ideas on their own.

In the provincial administration, each implementing organisation is administratively controlled by a department in the secretariat of the provincial government. The provincial housing boards are controlled by the housing department and the district rural development agencies by the rural development department. The secretariat department has powers over personnel, allocation of funds for establishment expenditure, approval of proposals to be funded by the provincial government and issue of necessary rules, regulation and orders. The implementing organisations may receive finances and programme guidelines from central or international organisations. Still, the administrative controlling department exercise considerable influence over the functioning. If such a department, recommends a new innovation

for adoption, such advice cannot be ignored. If such adoption is not violative of the guidelines of the federal organisation, the implementing organisation tries to move in that direction. It would also like the federal organisation to take the final decision. Typically the implementing organisation process this decision using a dual rationality approach. They would like to accommodate the interest of the controlling department without violating the interest of the federal organisation. They would also like to evaluate the options, so that they could balance these interests.

In our study, both handpumps (Vigyan design) and housing technology indicates this. The implementing organisations (pheds and housing board, etc.)., requested for field demonstrations. This provides them with valuable time to assess and balance interests as well as to evolve choice rules. The process was either interrupted as in the case of handpump (referring the issues for standardisation) or cycled through repetitive field trials as in the case of housing technologies.

Provincial implementing organisations show reluctance to be the first adopter of the innovation. Their dependent relationship with the federal agencies, and the close rapport between personnel of the two organisations, induce the provincial organisation to wait for the adoption process in federal organisation conclude. **6.5. Inter Organisational Network 6.5.1. The need for a network**

The development, adoption and implementation of innovations take place in a milieu where a number of organisations perform a

number of tasks in the innovation process. Figure 6.1 captures a glimpse of the milieu.

The figures gives an idea of the networking that is required to develop and disseminate the innovation. Even in market economies, where a product is sold without any subsidy, the function of standardisation and testing are structured by the governmental intervention. In case of the innovations requiring government subsidies for dissemination, the entire chain starting from technology evaluation, technology transfer, production, training and distribution to user must be structured by the adopting organisation. A set of dependent relationships between members develop in such a way to ensure dissemination of the innovation. This study has shown that the alliance of champions using an entrepreneurial strategy structured this network.

### 6.5.2. Structure and functions of networks

We have seen in all cases that organisational networks were essential. A closer look at the way the networks were formed shows the major role played by the innovator champion and the champion from the adopting organisation. Identification of manufacturers, training agencies and maintenance organisations was initiated by the innovator champion. Bringing the provincial implementation organisations and the standardisation organisation into the network was done by the adopter-champion. The role of each member of the network, the financial terms and other proceedings were worked out by the champion in the adopting

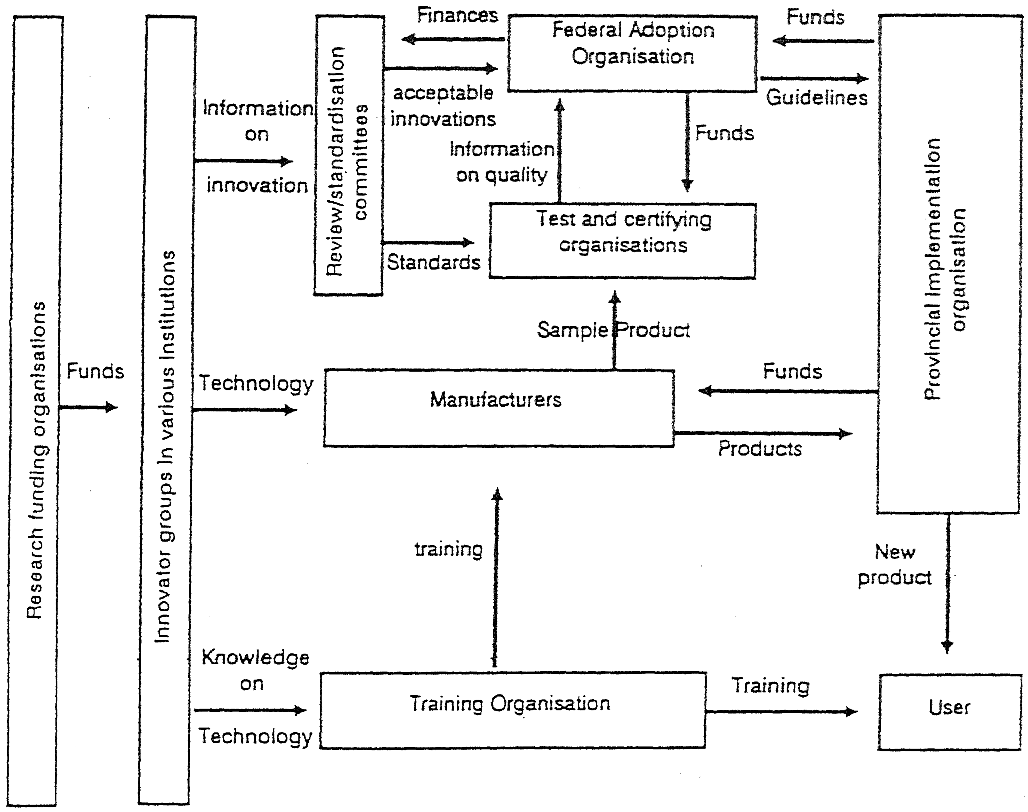


Figure 6.1: Organisational setting for the innovation process

organisation. The innovator champion looked after technical aspects like manufacture process, training methods etc. In that sense there was a division of labour among champions. This division of labour could be very clearly seen in the cases of handpump and gasifier.

The leadership of such a network was retained with the innovation adopting organisation which set up the network. Conflict resolution was normally by consensus arising out of bilateral agreements. However the power to arbitrate was left with the leader. There were no strict hierarchy within this network. Such networks enabled flow of (a) finances, (b) information across organisations. Another crucial task performed by the network is training of personnel of the organisations of the network.

We have noted that there was little formalisation of behaviour of members; the participants in the network could change by addition or withdrawal over time; each participant provided to the network some functional specialisation; a reliance on the liaison/boundary spanning individuals to encourage adjustment; selective decentralisation based on functions while retaining conflict resolution powers at the hands of the leader.

These are the elements of the adhocracy structure proposed by Henry Mintzberg (Mintzberg 1983). Though Mintzberg talked about the adhocracy structure within an organisation, the elements of adhocracy fits so well with the kind of networks

created by the alliances, we could term the structure as adhocracy. Mintzberg advocated adhocracy structure for innovations. Such adhocracies always have a strategic apex whose job is mainly in settling the disturbances that arise in these fluid structure.

In conclusion, innovation dissemination owes a lot to formation of alliances and their activities. This leads to networking various organisations into an adhocracy, so that the innovation dissemination does take place as planned by the alliance.

**6.6. Changes in focus of innovation**

The study has shown that as innovation proceeds from stage to stage there are reactions to it from other organisations. These normally take the form of suggestions desiring changes in the design features or changes in the system components or packaging or changes in the target market segment. The study has shown that innovators had evolved an a priori criteria to assess their innovations. These criteria normally tend to be technical criteria such as efficiency of the device, or manufacturing process or performance characteristics. As long as the suggestions do not lead to a change in these criteria and if the changes could lead to quicker progress of the innovation, the suggestions were accepted. However when suggestions for changes questioned the criteria of evaluation themselves, they were not accepted.

The interaction of innovators with other organisations could be thought to happen in a learning situation. As Argyris and Schon have shown (Argyris, 1978), people tend to be unable to reflect and question their own governing values. This behaviour is reinforced if there exists a strong sponsorship supporting their endeavour. We have seen this in the case of the stove, where suggestions for cost reduction were spurned.

The cases have also shown that suggestions for changes emanating from peer scientists have a better chance of acceptance than emanating from non-scientists. This may have to do with the identification and acceptance of peer scientist as part of their own group by the innovators.

### 6.7. Role of Committees

Committees in these cases performed two important tasks. They promoted development of innovation at every stage without much critical examination of the possible future scenario. Committees deciding on funding for technology development did support projects, even when a number of other groups were working on the same innovation. There were no comparative evaluation of work of different groups. This led to multi locational development.

Secondly the committees constituted to evaluate various innovations arrived at a consensus. This normally led to fixing of low threshold values for efficiencies etc., so that a number

of innovations became eligible for promotion under government programmes. This was done in order to minimise if not eliminate dissent among scientific community.

Nominations to these committees were made by the adopting department of the government concerned. The suggestion for nomination flowed from the executive officer in charge of the programme. The nominations were made in such a way to give representation to all interest groups. Innovators representing a number of innovations were thus nominated. Studies into the behaviour of work groups in organisational settings (Brown, 1980), have shown that preservation of cohesion of the group takes precedence over performing the task. The composition of R&D sponsoring committees or review, standardisation and assessment committees were marked by members having similar status. The committees operate more like clubs, meeting the social needs of the members. In order to preserve group cohesion and minimise dissent among members, they tend to uncritically promote a number of innovations, leaving the decision making back in the hands of the executive officer of the department concerned.

This passes the leadership of the process to the executive officer of the department concerned. And if he happens to be champion of an innovation, as has been shown in this study, the committees tend to get reduced to the task of merely providing legitimacy to functioning of the champion and his strategy.

## 6.8. Towards a Schema of Innovations in Multiorganisational Settings

The conclusions that have emerged from this study enable us

to hypothesise a schema of innovation process in multi organisational settings. This is depicted in Table 6.1. The process occurs in three distinct phases, the development phase, the adoption phase and the implementation phase. Major activities in each of these phases are located in an organisation, operating in an environmental context and an organisation context. In this study the development phase had a locus of activity in an academic institution. The locus of activity shifted to a government department or agency during the adoption phase. The network took over the activities during the implementation phase. It may be worthwhile to closely examine the process at each of the phases.

**6.8.1. The development phase**

A number of forces act upon the innovator(s) during this phase. On the one hand the innovator(s) belong to an scientific community, with a shared view about research problems. This peer influence forces the scientist to adopt current international research problems as his priority. This peer pressure is even more acute in premier institutions like Vigyan. On the other hand the scientist is situated in a developing economy and questions regarding relevance of his work to local conditions are being raised. The scientist has to strike a balance between the desire to be socially relevant and the need to be part of scientific community. Attempts at innovation that be of a great significance to social development, though not de novo, are made by scientists having a desire to be socially relevant.

| Phase of the innovation | Innovation function (after Pelz) | Organisations involved | Nature of champion process | Organisation strategy set in motion | Kinds of strategy used by champions | Impact of the strategy on Dec.process | Influences helping innovation | Influences against innovation |
|---|---|---|---|---|---|---|---|---|
| Development phase | Recognition, search, appraisal, design | Research funding organisation, laboratories/academic institutes | Scientist acts as champion | Organising resources, seeking approvals for design funding | Adaptive strategy | Is in consonance with the decision process adopted by these organisations | Expectations of social relevance from the environment, freedom existing in research laboratories | Pressure from scientific peer group, lack of a reward system for socially relevant innovations |
| Adoption Phase | Commitment, incorporation | Laboratories/ institutions, federal planning and financing agencies, evaluation committees. | Scientist champion and an officer from the federal planning/ financing agency act as champion Alliance of champions cones into being | Committment building, removing barriers, seeking approval | Entrepreneurial strategy | Quickens the pace of 'organisation process'. If barriers are strong, shifts the decision process to a political process | The charter of the federal agency; expectations from the legislature, ministers etc.; availability of finances | Burecratic procedures; dissent among scientific community |
| Implementing Phase | Diffusion | A network of organisations consisting manufacturers, trainers, provincial implementors, federal agencies and others | Alliance of champions | Committment building; organising resources; structuring networks | Entrepreneurial strategy | Quickens the decision process in each of the network organisation | Availability of finances, status fulfillment | Dissent among network members |

[illegible] A framework of innovations in multi-organisational settings.

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A framework of innovations in multi-organisational settings.

The organisational context in which the innovator work is characterised by a high degree of freedom given to the scientist in choice of problems, methods of execution of the research and promotion of research results. But there is very little support to the scientist, should he face a problem. Resource and support mobilisation is entirely left to the innovator. The innovator is then an autonomous individual left to his own devices. The reward structure as it exists in these institutions encourages the scientist to be current with the international community of scientists and his work of social relevance does not merit much consideration.

The environmental context for the development phase of innovation is determined by the policies of research funding organisations. Since most of the research funding organisations are controlled by the government, there is a tendency among them to apportion certain fraction of their funds to socially relevant research. Being government organisations, their performance are reviewed by the elected representatives who lay a greater emphasis on the relevance of research to local conditions. By creating special programmes, these funding organisations encourage research leading to innovations with large impacts. They function mostly as research funding organisations and not as innovation promotion organisation. There is no effort towards promoting the innovation across phases towards adoption. That task as has been seen in these cases was left to the innovator.

The innovator experiences, in his organisational as well as in the environmental contexts, two pulls in different directions.

His standing as a scientist and his rewards are determined by his close identification with the scientific community with an international set of problems. There are, on the other hand, forces which induce him to take up innovation that are socially relevant. Neither his organisation, nor the environment enthuses him to champion the cause of the innovation. If he chooses to be champion it is only on his own will.

### 6.8.2. The adoption phase

When an innovator decides to champion his innovation towards adoption and use, the locus of activity shifts from his laboratories to the adopting organisation. The leadership of the process also shifts from him to a champion in the adopting organisation. The process is now more complex with a larger number of actors. For one, there are a number of innovations for the same task, clamoring for adoption. This forces th?? adopting organisation to evaluate and choose. The innovators of various innovations exert a pressure on the adopting organisation.

The adopting organisation, normally a government department, has been mandated by law to provide certain services. The organisation is under constant review by the legislature, the ministers, the auditor general, the planning commission, the press and others. There is a pressure on them to be more efficient, to introduce new technology and so on. They are looked upon as change agents. They are held responsible for deeds and misdeeds in their area of operation. Innovators as well as forces

from the environment, pushes the adopting organisations to choose and implement new innovations.

But these organisations are bureaucracies with a system of checks and balances. The decision makers are accountable for their decisions. We have seen the use of an organisational decision process to arrive at decisions. This involves use of committees, minimise dissent and does not promote large departures from existing practice. This leads to uncritical acceptance of all innovations and the choice does not get made, it is shifted to another level or to another organisation. This increases the time taken by the innovation to get into use and the innovator champion may lose his interest.

However existence of an active champion within the adopting organisation, as has been shown, builds on the positive forces which induce the organisation to be change agents and the strategy set in motion by the innovator and this champion, cuts the delay in organisation process and is able to get the innovation adopted.

What are the forces acting on the champion from within the adopting organisation? There are no forces in his organisation which pushes a bureaucrat to be a champion. The reward structure does not value entrepreneurial ability. He also occupies a position for a short duration of 2-3 years. As the case of innovator, the bureaucrat also become champion only due to his personal make-up and not because of organisation forces.

### 6.8.3. The implementation phase

The locus of the activity now shifts to a network and a number of bilateral arrangements are introduced. Manufacturers, trainees, maintenance crew, provincial imp?meeting agencies and quality certification agencies are brought into picture. Three types of relationships emerge. These are relationship, as between federal adopting organisation and the provincial implementing organisation, mandated by law to fulfill certain legal requirement. There are economic relationship, as between a financing organisation and the manufacturer. Then there are social relationships, as between innovator and trainers etc. The parties in the network derive certain benefits either economic or social due to the innovation. They develop a stake in the replication of innovation.

What are the forces that enable the creation and sustenance of networks? There are economic consideration, as large amount of funds flow through the network. There is also a prestige of being associated with a new, socially relevant, 'mega' innovation. Network would also have conflicts over time, since each member may want to maximise his benefit. The sustenance of the network is in the leadership and in the conflict resolution process. We had mentioned that the network is an adhocracy, which is essential for innovation. But maintaining an adhocracy over a period of time is difficult.

## 6.9. Multiorganisational Innovation Process - Towards a Conceptual Framework

Conventionally innovation process has been viewed as a succession of stages, occurring sequentially in time. Our case studies enable us to look at the innovation process from a different perspective.

The multiorganisational innovation process, as we have seen, is promoted by champions. Champions evolve and implement their strategies. Scientist-champion, has his own strategy for promoting the innovation. The administrator-champion has a strategy to promote his interests. Promoting the innovation is a way of fulfilling his other goals. There are some commonalty between the strategies of these two champions and that is why they are able to strike out a common strategy, together. Alliance formation is then one of the steps in the activation of the strategy by the champions.

The activation of the strategy of the champions include developing and putting in place a structure that will have a close fit with the strategy. The structure for promotion of the innovation consists of the alliance of champions and the network. The network comprises of manufacturers, quality certifiers, provincial implementors, trainers, innovators. This structure is then able to provide the resources, namely financial, manpower and knowledge resources, required for the innovation.

This structure centralises the power to resolve conflicts in

the hands of the leaders but decentralises the power to control the production of functions specified for each member. The structure, as we have noted earlier, is flexible with fluid participation.

Another element in the activation of strategy of the champions is their mediation of processes that happen during the innovation.

The five cases discussed in this study, indicate four distinct processes connected with innovation. They are (a) Development process (b) Adoption decision process (c) Evaluation/standardisation process and (d) Networking process. A description of these processes are in order.

The <u>Development Process</u> is essentially a technical process. This is concerned with the design of innovations. Innovations can be considered of having a core set of characteristics and an outer peripheral set of characteristics. Features such as efficiency, methods of manufacture, performance, and engineering specifications form the core set. Accessories, packaging, nature of use, and intended market segment belongs to the peripheral set. Our cases have shown that right through the innovation process there are suggestions for changes in the nature and focus of innovation. In fact suggestions have been made to alter characteristics belonging to either the core or the periphery or both.

We have noticed that the strategy of champions mediate the

interaction between innovators and those seeking changes in the innovation. More often than not, as our cases have shown, that suggestions for changes in the core characteristics have not been accepted, while suggestions for changes in the peripheral characteristics have been accepted, and innovations have modified the innovation.

This shows that, even though bulk of the technical design of an innovation may have been completed, the development process of innovation with its changing focus goes on. In that sense innovation is not really complete, though innovators may think it to be so.

The <u>Adoption Decision Process</u> takes place in our cases in a federal level organisation. This decision process normally follows, the consensus seeking, dissent minimising, satisficing approach. Our study has shown that the strategy of champions influences this process considerably. There is also a feedback to the development process.

The Adoption Decision Process is influenced on the one hand by the strategy of the champion and on the other by the evaluation/standardisation process.

The <u>Evaluation/Standardisation Process</u> is set in motion by the adopting organisation. This process, as our cases have shown, essentially follows a consensus seeking, dissent minimising approach. This process is also influenced by the strategy of champions. this process leads to a charge in the

design characteristics of the innovation. Thus it contributes to the development process, in addition to its contribution to the adoption process.

We have seen that this process, by being dissent minimising, allowed all competing innovations to stake a claim on the adoption process. Though initiated by the adopting organisations, this process does not benefit much the adoption process. This process would continue even after the innovation gets adopted as the diffusion might lead to changes, which in turn have to be evaluated. For instance the draft standard in the case of handpumps were revised within a year and the NSO was willing to consider a review of the standard after two years.

The <u>Networking Process</u> involves identification and enlistment of members into the network. Their roles have to be delineated and relationships that govern resource flows have to be formed. This process of structuring a network, is initiated by the alliance of champions. Their strategy influences the nature of relationships that emerge. Information flow among members has to be ensured. The network is essential for the diffusion to take place. The network as it functions acts as the interface between user and the federal level organisation. We can expect that the network would contribute to the development process by passing on the user's reaction to the innovator group. As the participation in network is fluid, and as the innovation changes over time, the networking process will also continue.

Summing up, we state that these four processes governing the

progress of the innovation, may start at different points in time, but would run concurrently, till some reasonable amount of diffusion is achieved, or till a better innovation emerges. Each process influence each other and the processes are largely determined by the strategy of champions.

We can then view multiorganisational innovation as an outcome of the entrepreneurial strategy employed by the champions. They implement this strategy (a) by putting together an enabling structure consisting of alliance of champions and a network and (b) by mediating in the processes of development, adoption, evaluation and networking. A pictorial view of the multiorganisational innovation with this perspective is presented in Figure 6.2.

## 6.10. Implication for Management of Innovation:

The recognition that the innovation is made up of interlinked, strategy mediated, processes of development, adoption, evaluation/standardisation and networking, leads us to a different way of structuring and managing innovation process in the Indian environment.

The research and development organisations must understand the process does not end with the first design. All four processes run together, though at a point of time the major activity may be centered around one process. This means that an innovation is a long duration process. In our cases, nearly a decade was spent, even before some little diffusion could take

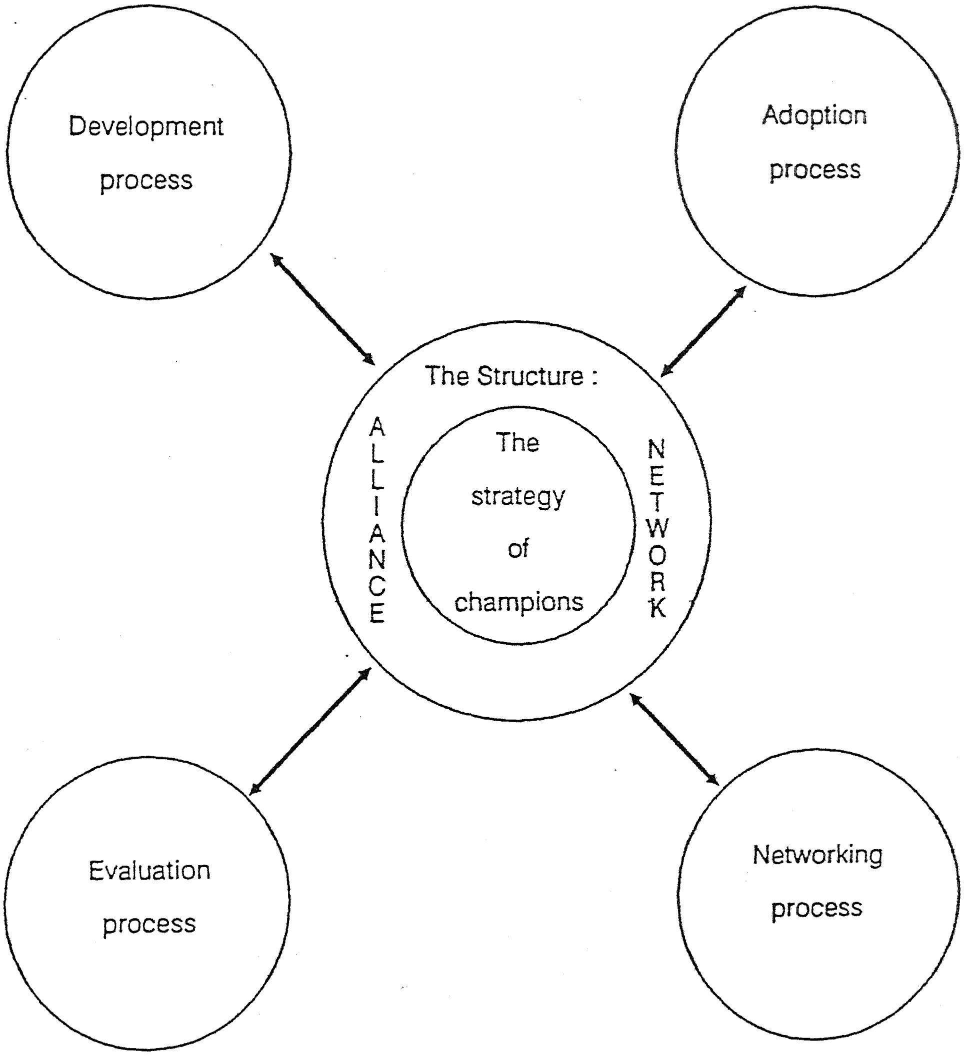


Figure 6.2 : Strategy, structure and processes of a multi organisational innovation

place. The institutions must support the innovation over a long time.

The research and development organisations must look for champions and encourage them. Our cases have shown that it is not necessary for the innovator himself to be champion. Any scientist with a close rapport with innovators and with entrepreneurial drive could undertake this task.

The champions from research organisation must seek out and form alliances with champions in the adopting organisations. The champions influence the process using a entrepreneurial strategy.

The adopting organisations on the other hand need to identify champions among their men and enable these identified champions to function as innovation champions. The checks and balances, that are inherent in the bureaucratic process, must not come in the way of flexibility demanded by champions.

We have also noticed that evaluation process is not selective. There is a real danger of inferior innovation getting adopted if it has an active champion. Attention must be given to this aspect and a methodology for technology assessment evolved, by the adopting organisation.

In the networking process, the important aspect of conflict resolution is left to the adopting organisation. The federal organisation also plays the role of leader of the network. We have noted that network is an adhocracy with fluid participation, functional specialisation, decentralisation of power over

functions and informal relationships. Such a structure can be maintained only by an imaginative leadership who strives to minimise conflicts. The adopting organisation at the federal level need to provide such a leadership.

These studies have shown that research sponsoring organisations do not play the role of champions. They could aid the process, in a number of ways. They must be prepared to fund the innovators over a long period of time, as innovation is not merely emergence of the first prototype. The subsequent development necessitated by the processes of adoption, evaluation and networking, requires resources. Secondly, research funding organisations can establish active interaction among themselves and avoid duplication at multiple locations. They can promote active cooperation among various innovation groups, so that cross fertilisation of ideas take place.

The view of the innovation as a continuing, evolving, interlinked processes of development, evaluation, adoption and diffusion mediated by the strategies of champions, would then hopefully help in creation and adoption of newer technologies in developing economies.

CHAPTER VII

# LIMITATIONS OF THE STUDY AND SUGGESTION FOR FURTHER WORK

## 7.1 The Case Study Method:

A major limitation of our study is the methodology used for the study. Though fresh theory generation through induction i a major strength of the case study method, this requires replication of the study across a number of cases. Practical difficulties such as time, resources at the disposal of the researcher and other logistical factors restrict the number of cases. For example our study analysed only 5 cases. Development of a theory bases on such small set of data always pose problem.

Our study has also relied on written records as the major source of data. Recording of events and discussions, by any individual is selective, however close in time the recording to the event. The cases in the study have also relied on the memory of actors to fill the gaps, identified in written records. Our cases have spanned nearly a decade and there is always a problem of recall of events. These limitations of the case study method can be overcome if other researchers undertake similar cases and look for similar patterns.

## 7.2. The Innovations :

The cases presented in this study are innovations that were

not highly novel and all of them originated in one single institute. This restriction in itself is a serious limitation if one attempts to generalise the conclusions of this study.

Within any organisation, the technology in use contributes to the determination of power relationships and resource allocation. Introduction of highly novel innovations then would attempt to change the relationships. Would, champions of innovations, then be able to steer the process using an entrepreneurial strategy?

Some novel innovations are introduced under government programmes too. For instance, remote sensing techniques using satellite imageries are being introduced in government programmes to assess damages done by natural calamities. They are intended to replace centuries old procedures. A similar study, but with cases on novel innovations may yield some general theory on strategies of successful champions.

**7.3. The Research Institution**

A major weakness of this study is that it has not analysed organisational characteristic that impinge upon innovation process. It has tried to eliminate this aspect by choosing innovations from one single institute. What organisational features promote emergence of champions is an interesting aspect, that was not looked into.

In this study four innovations, emerged from a single

academic institute, Vigyan. This was deliberately done to avoid influences of research organisation's features on the process. But in developing countries like India most of the technological innovations are attempted in government owned specialised research labs or in the laboratories attached to big industries. The structure of these laboratories are quite different and there is a specific mandate to them to produce innovations.

We had seen that scientists from vigyan enjoyed a very high degree of freedom in choice of problems, in mobilisation mobilisation of resources and in dealing with other organisations in the course of the innovation. Such degree of freedom are not available to scientists in other laboratories. Organisational features of Vigyan certainly helped the innovations acting as champions. A study into relationship between organisational features such as structure, power distribution, decision process and the likelihood of emergence of a champion would throw more light on this gray area.

Secondly, Vigyan enjoys a pre eminent position among research institutions. The aura of belonging to such an institute, adds on to the championing efforts of the innovator champions. This study itself has noted that administrator - champions, when looking for alliances, were eager to link with Vigyan though they had opportunities to link with other innovator groups. What kinds of championing efforts is needed, when an innovation emerges from a lessor known institution? If innovator champions, have to seek alliances with administrators, how should they go about it? A study in to this aspect will firm up the

modes of formation of alliances. **7.4 Adopting Organisation**

In this study we have focused on the adoption process when the adopting organisation is government owned and controlled. We had also noted that cook stoves, gasifiers, housing techniques, and silicon could reach the user through market mechanisms or through non governmental, special interest groups like energy conservation associations. Would a champion from the adopting organisation still be necessary? We can hypothesise that when the adopting organisation is a Non Governmental Organisation, a champion from within NGO may be useful, since organisational process of choice in NGO's are very similar to that of government. But, when the intended adopting organisation is a commercial one, should the innovator champion look for and strike alliance with a champion in the firm?

**7.5 Champions :**

A major limitation of this study is that it has not looked into the motivational aspects of the champion. We have also not analysed the nature of the champion, his leadership abilities and his aspirations. We do not know why he acts as a champion.

We must note that in all cases, the administrator champions were either chief executive officers of their organisations or chiefs of the divisions responsible for the technology. Would they have been equally successful if they were not chiefs, but a middle or lower level executive?

We have noted that in two cases (stoves, handpump (RAC)), the scientist champion was not the innovator. But that did not

hamper the process, since the innovators supported the scientist champion and provided all assistance. There could be friction between innovators and scientist champion. Even in this small set of five cases, we find friction between innovators and scientist - champion (The case of cookstoves). How the relationship between a scientist champion and the innovators is managed will be an interesting study.

### 7.6 The Network of Organisations :

A serious limitation of this study is that it ends with the formation of the network and the start of the diffusion programme. A study into the functioning of the network, the leadership, and the conflict resolution process, after a few years of diffusion will be useful, in determining the kind of networks (formal, informal, loosely coupled etc.) and the mode of its management that would enable a rapid diffusion of the innovation.

The second question worth examining will be the functioning of the network after the governmental support, subsidy etc. are withdrawn.

### 7.7. The Diffusion Process

In this study we have concentrated on diffusion originating from the federal level adopting organisation and hence our focus on the adoption process where champions played a dominant role. We have also noted that attempts at influencing provincial level organisations were not successful, since they waited for the

federal organisations to approve the innovations.

There have been cases where the federal organisations have adopted a new innovation after it had successfully diffused in a small territory among private users. For instance, in this study too, in the case of housing technologies, the Houseco and the housing bank adopted the technology after some sixty individual users had adopted and put up their own houses. When adoption in government programmes is attempted, after the innovation has been first adopted in non - governmental sector, would administrator - champion be still necessary? Secondly will the innovator need to use, highly risky, entrepreneurial strategy even then?

## 7.8. Small Groups

This study has shown that a number of small groups are involved in the decision processes of governmental organisations. The process of their constitution, specification of terms of reference, mode of their functioning, leadership of the group and their impact on the organisation are issues not elaborated in this study. We have noted that champions were able to use the small groups to their advantage. An in-depth study of small groups with respect to innovation process will be useful.

As has been noted earlier, innovation research is still in its theory building phase. Further case studies, focusing on issues mentioned above will enable us a deeper understanding of the phenomena of innovations.

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